MODERN PLASTICS

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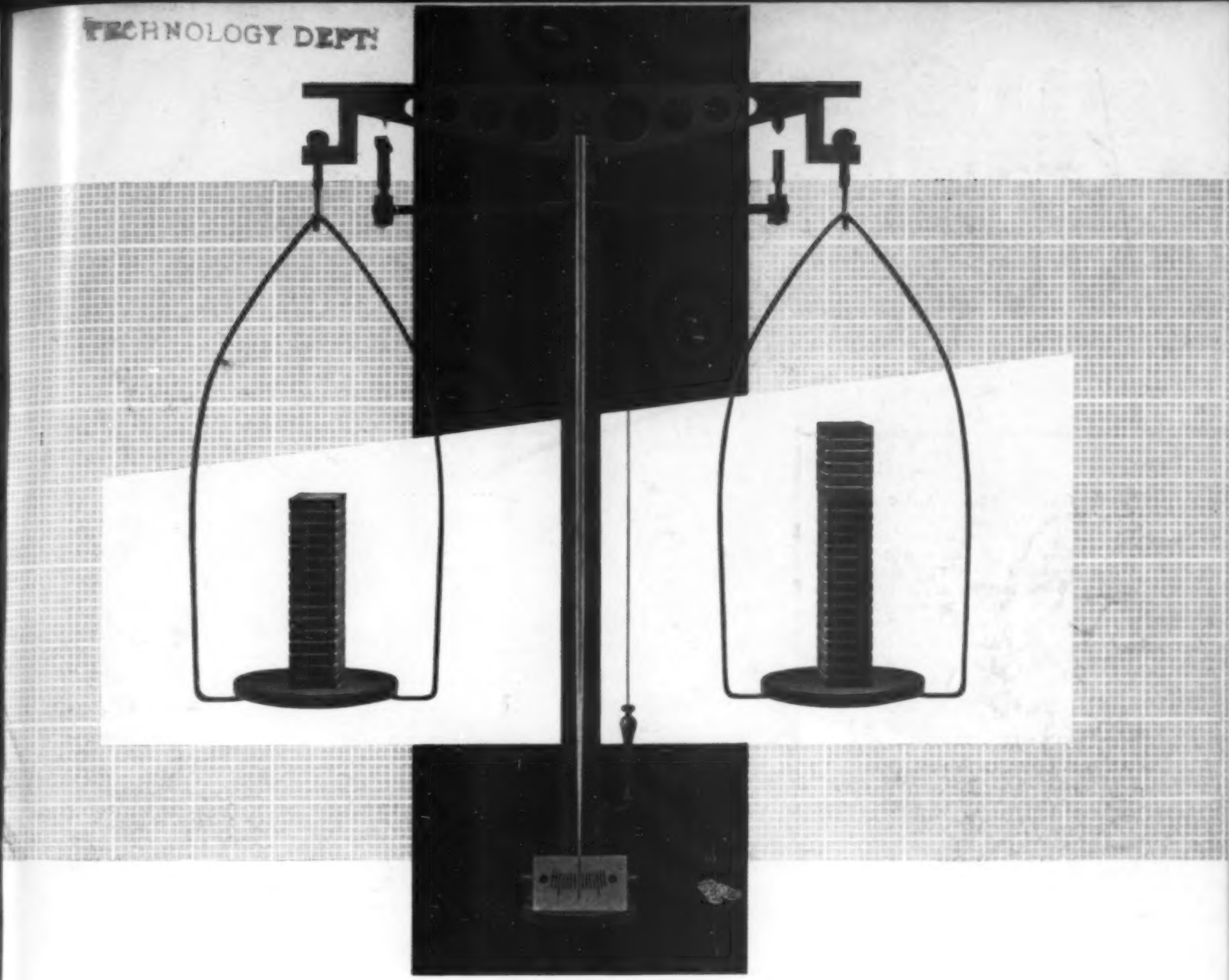
JUNE 1943



modern plastics

INCLUDING Plastics ENGINEERING

VOLUME 20 JUNE 1943 NUMBER 10

GENERAL INTEREST

PLASTIC ENGINEERING

TECHNICAL SECTION

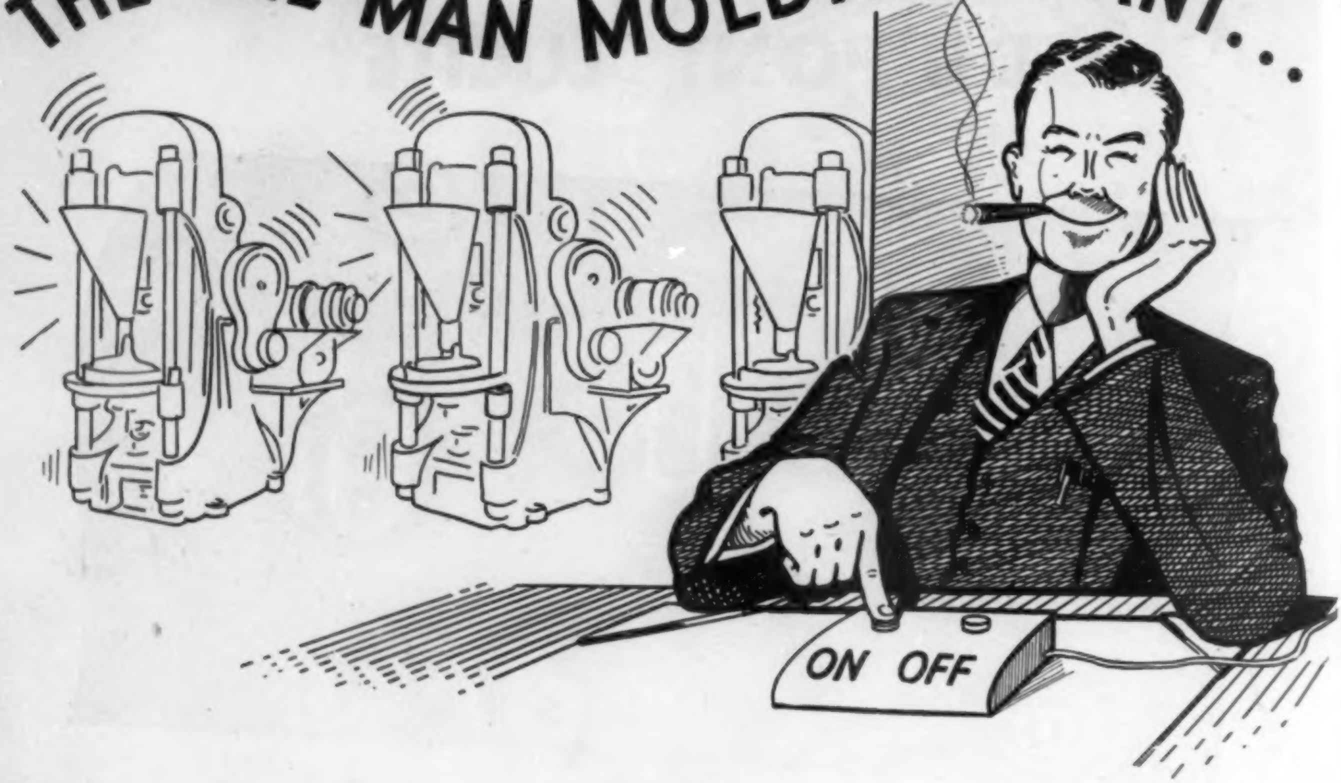
NEWS AND FEATURES

EXECUTIVE and EDITORIAL OFFICES: 122 E. 42nd St., New York N. Y. WASHINGTON, D. C. OFFICE: 625 Colorado Bldg., 14th & G Sts.

Published the 5th of each month by Modern Plastics, Incorporated. Publication Office, Twentieth and Northampton Sts., Easton, Pa. Subscription price $5.00 per year, $8.00 for 2 years in U. S., its possessions and South America. Canadian subscriptions $5.50 per year, $9.00 for 2 years; all other countries $6.00 per year, $10.00 for 2 years, payable in American money or its equivalent. Price 50¢ per copy.

Printed in U. S. A. Entered as second class matter May 28, 1940, at the Post Office at Easton, Pa., under the act of March 3, 1879. Member of the Audit Bureau of Circulations. Back numbers 3 months or more preceding current issues, when available, $1.00 each.

THE ONE-MAN MOLDING PLANT...



BIT by bit the plastics molding industry
Is improving its equipment.

Presses are becoming really and fully automatic,
So one man can take care of many.

Finishing the parts—a tough problem—
Is following the same path.

Given time we hope to know as much about
Our product, and how to handle it,
As the metal people do about metal.

We doubt if we ever reach the ideal condition
Shown here, but we are trying hard.

And the improvements we make

Will sometime be of benefit to you
When you buy plastics

By giving you cheaper and better parts.

Right now—like you—we are up to our neck
In war.

But we hope to be good people to know
After said war.

Please file our name with your plans—
Not with your souvenirs.

"A Ready Reference for Plastics" written for the layman, is now in a new edition. If you are a user or a potential user of molded plastics, write us on your letterhead for a copy of this plain non-technical explanation of their uses and characteristics. Free to business firms and government services.

ARMY E NAVY

BOONTON MOLDING COMPANY
MOLDERS OF PLASTICS · PHENOLICS · UREAS · THERMO-PLASTICS
BOONTON · NEW JERSEY · Tel. Boonton 8-2020
N. Y. Office—Chanin Bldg., 122 East 42nd Street, Murray Hill 6-8540

Only the best is good enough for War Contracts

Everyone who has done business with several molders knows that no two are alike. Their plants are different. Their experience is different. Most important of all, their mental attitudes are different. They see your requirements from separate viewpoints—handle your work with varying degrees of competence and intelligence.

Here at Auburn we think that when you've given a job to a molder you want to forget about it, knowing it will be done on time and right. You want the molder's finishing to be perfect and his inspection hard-boiled. You want him to discard the seconds, the "maybe-they'll-get-by" pieces, so there will be no waste time in your own plant and your production line will keep moving.

In short, here at Auburn, we think you want a molder capable of gearing his mind to your problems and of adapting his production to your needs. Any molder may give you your money's worth. Only the molder whose equipment includes the ability to give you intelligent cooperation can give you the *most* for your money. If we can help the war effort by helping you, let's get together at once!

MOLDED PLASTICS DIVISION

AUBURN BUTTON WORKS, INC.

Molders of All Types of Plastic Materials by Compression, Transfer Injection and Intrusion Methods

ESTABLISHED 1876 AUBURN, N. Y.

NO JOB TOO *Large*
NO JOB TOO *Small*

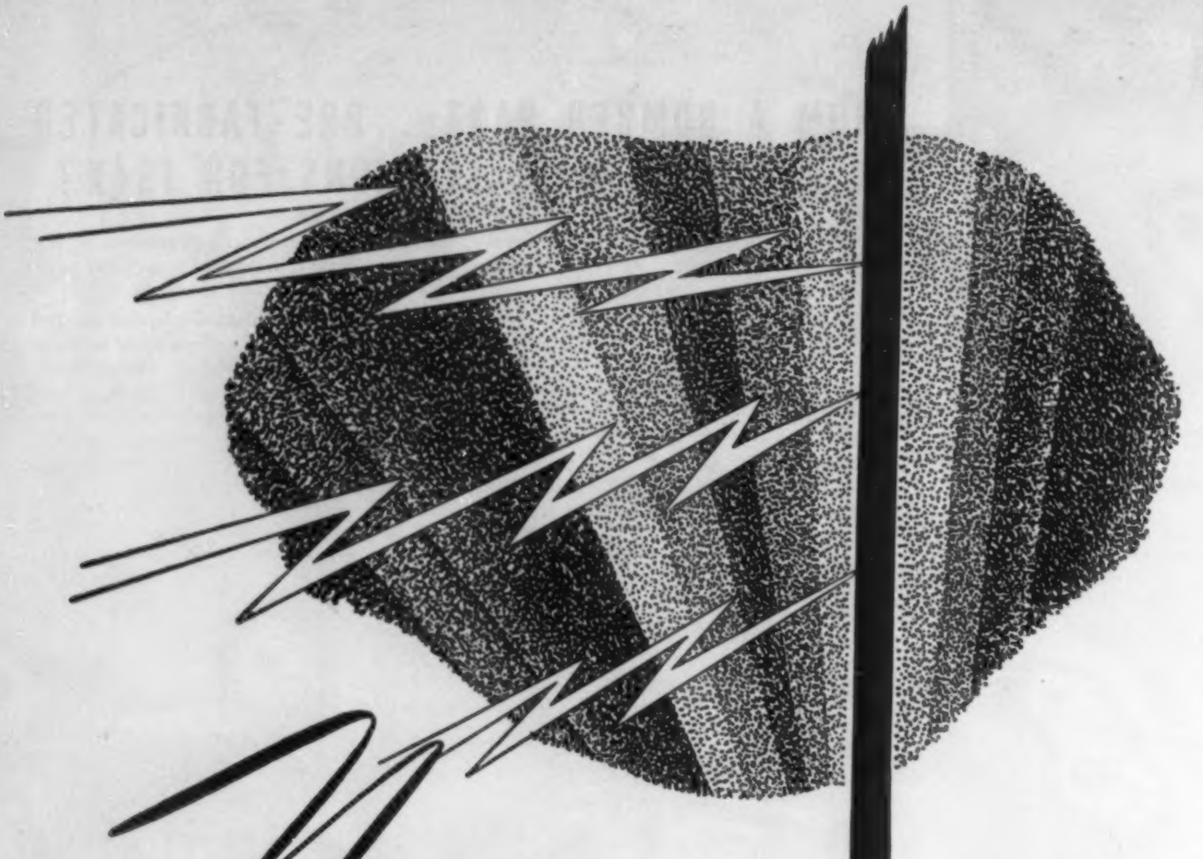
★ At Midland Die and Engraving Company you'll find complete facilities for Plastic Molds, Die Cast Dies or Hobbings, Engraved Dies, Steel Stamps or fine Pantograph Engravings—facilities complete under one roof and unsurpassed in the entire industry ... For example, hobbing presses ranging from 100 to 3000 tons as well as complete tool and engraving departments are at your instant service always.

Investigate! Regardless of individual job size or tolerance you will find that Midland's ideal combination of complete facilities plus painstaking attention to pertinent detail assure getting the job done properly—and in the shortest possible time.

FOR VICTORY BUY UNITED STATES SAVINGS BONDS AND STAMPS

MIDLAND DIE AND ENGRAVING COMPANY
1800 W. BERENICE AVENUE • • • CHICAGO, ILLINOIS

Makers of Plastic Molds • Die Cast Molds • Engraved Dies • Steel Stamps • Hobbings • Pantograph Engraving



New BARRIERS *to Confine Electric Current!*

War is destructive but not all effort that goes into the big fight is wasted. Some of it is going to pay mighty big future dividends. That is especially true of the war work that is going on in the country's laboratories.

At Formica this work has resulted in the development of some new insulating materials with new and valuable characteristics which will be doing important jobs in American electrical products long after the war is over.

Three new grades MF, FF-10 and FF-41 accomplish things that could not be done previously with this laminated insulation. MF is a glass mat base for applications requiring low loss at radio frequencies (Power Factor .011; Dielectric Constant 4.6; Loss Factor 0.05 at 1 Megacycle).

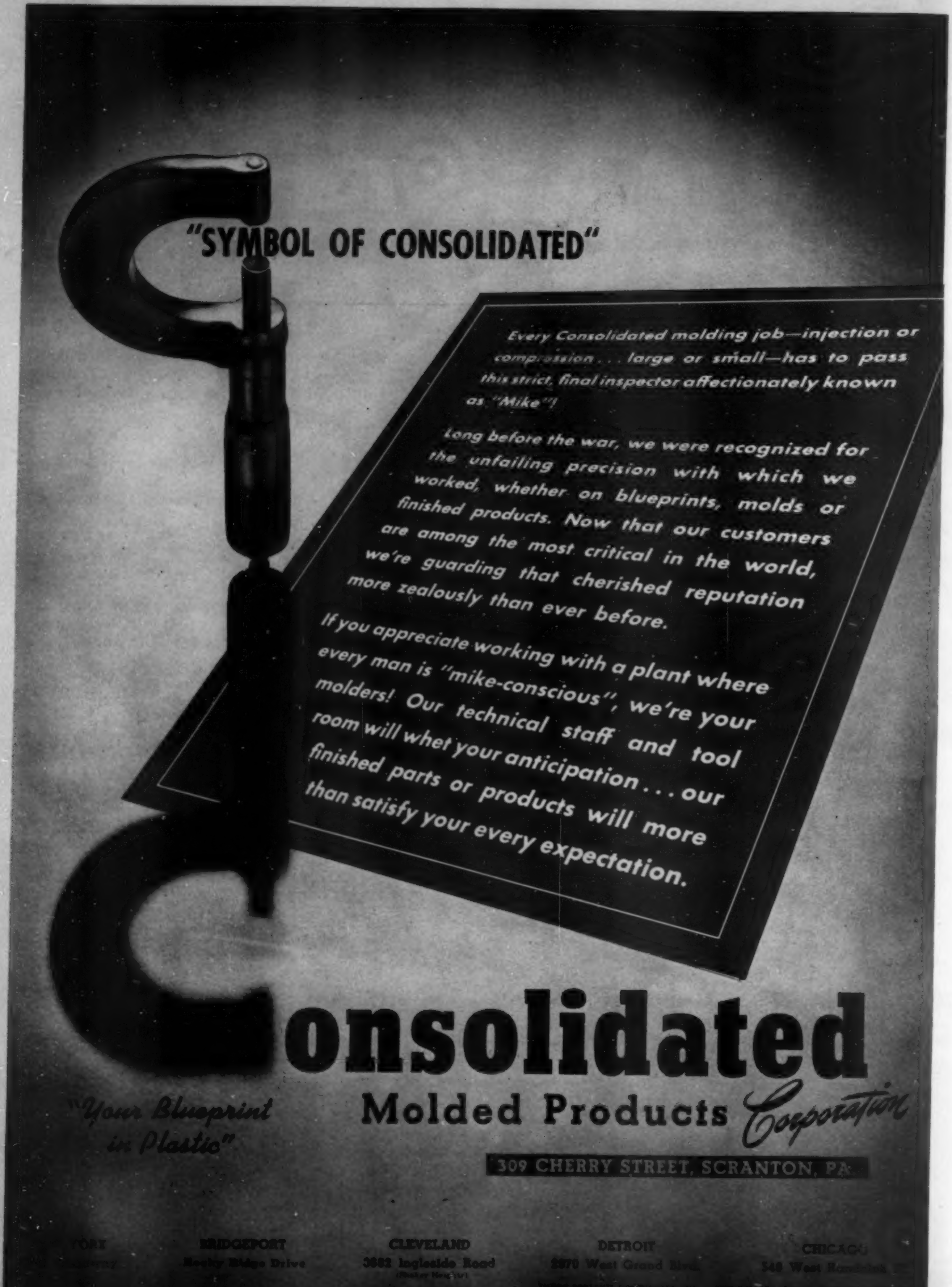
F-10 is Fiberglas fabric base material combining good dielectric strength and heat resistance. And FF-41 is designed to resist arcing.

These materials have a new and important usefulness. At present they are available only for the most essential war uses. But later they will be widely applied.

ARMY E NAVY

FORMICA

THE FORMICA INSULATION CO., 4673 SPRING GROVE AVENUE, CINCINNATI, O.


"SYMBOL OF CONSOLIDATED"
Every Consolidated molding job—injection or compression . . . large or small—has to pass this strict, final inspector affectionately known as "Mike"!
Long before the war, we were recognized for the unfailing precision with which we worked, whether on blueprints, molds or finished products. Now that our customers are among the most critical in the world, we're guarding that cherished reputation more zealously than ever before.
If you appreciate working with a plant where every man is "mike-conscious", we're your molders! Our technical staff and tool room will whet your anticipation . . . our finished parts or products will more than satisfy your every expectation.
Consolidated
Molded Products Corporation
"Your Blueprint in Plastic"
309 CHERRY STREET, SCRANTON, PA.
BRIDGEPORT
CLEVELAND
3882 Ingleside Road
DETROIT
CHICAGO

"SITTING ON TOP OF *The World*"

Beauty and strength reach new heights in SINKO Precision Injection Moldings. That's why there's such a definite feeling of satisfaction..figuratively "sitting on top of the world"..for users of the better moldings we make.

If you are planning, now, a new or improved product designed to capture a big share of post war sales and profits, let's talk it over! Perhaps our skilled engineers may offer valuable suggestions. Possibly a SINKO Injection Molding can do the job better at less cost. Suggestions, ideas, cost estimates involve no obligation. Phone or write us or our nearest representative today!

Sinko

PRECISION INJECTION MOLDING

SINKO TOOL & MANUFACTURING COMPANY, 351 NO. CRAWFORD AVENUE, CHICAGO, ILLINOIS

REPRESENTATIVES: L. D. MOORE, 4030 CHOUTEAU AVE., ST. LOUIS, MO. • POTTER & DUGAN, INC., 29 WILKESON ST., BUFFALO, N.Y. • ARCH MASON, 259 CENTRAL AVE., ROCHESTER, N.Y. • H. O. ANDERSON, 202 HERALD BLDG., SYRACUSE, N.Y. • PAUL SEILER, 7779 CORTLAND AVE., DETROIT, MICH. • QUEISSER BROS., 108 EAST NINTH ST., INDIANAPOLIS, IND.


AMMUNITION
BOX
CALIBER .50

New brush gets chemical bristles

HERE USED AS a coating over rayon cord, cellulose acetate again shows its unique versatility, its unique combination of advantages. The problem was this: supplies of Chinese hog bristles, traditional material for good paint brushes, were gravely threatened by war. Could a man-made bristle be devised to match the characteristics of natural bristle?

RESOURCEFULLY, LIKE SO MANY manufacturers who need several properties in a single material, Devoe & Raynolds turned to cellulose acetate. They needed *flexibility*, and acetate is highly flexible. They needed *toughness*, and acetate is tough. And they needed acetate's resistance to oils. These characteristics, coupled with an ingenious mechanical process, now produce this timely help for painters.

IF YOU HAVE A PROBLEM in plastics, you will do well to look searchingly into acetate. Toughness and flexibility are only two of its properties . . . acetate also provides high clarity, light weight, swift and varied fabrication. The literature we have for you is based on our years of experience in supplying those who make plastics with acetate of exceptional quality. Your letter should be addressed to Dept. MP-63.

HERCULES

CELLULOSE ACETATE

★

TOUGH • FLEXIBLE • STABLE
LIGHTWEIGHT • ECONOMICAL • CLEAR

HERCULES POWDER COMPANY · WILMINGTON, DELAWARE
Incorporated

Official U. S. Navy Photograph

The plastic ferrule on the pencil was molded by UNIVERSAL

FERRULES TO BULLETS.....

When brass went to war, plastics had to take its place on hundreds of products. The tiny brass ferrule of your pencil may not seem worth saving until you start figuring it in hundred million quantities. It runs into tons of critical brass released to help make bullets for our boys to use against the enemy. The new plastic ferrule illustrated is lighter, more attractive in appearance and is generally an improvement over the metal it replaced. Plastics are replacing metals everywhere, not only temporarily in many cases but also permanently. When Victory comes, consumers will continue to demand products whose appearance and convenience are improved with plastics. To manufacturers looking for post-war markets we offer a versatile molding service . . . sound engineering design, molding by compression or injection methods, all finishing operations . . . everything under one roof in our modern plant at New Brunswick, New Jersey.

Submit your inquiries without obligation.

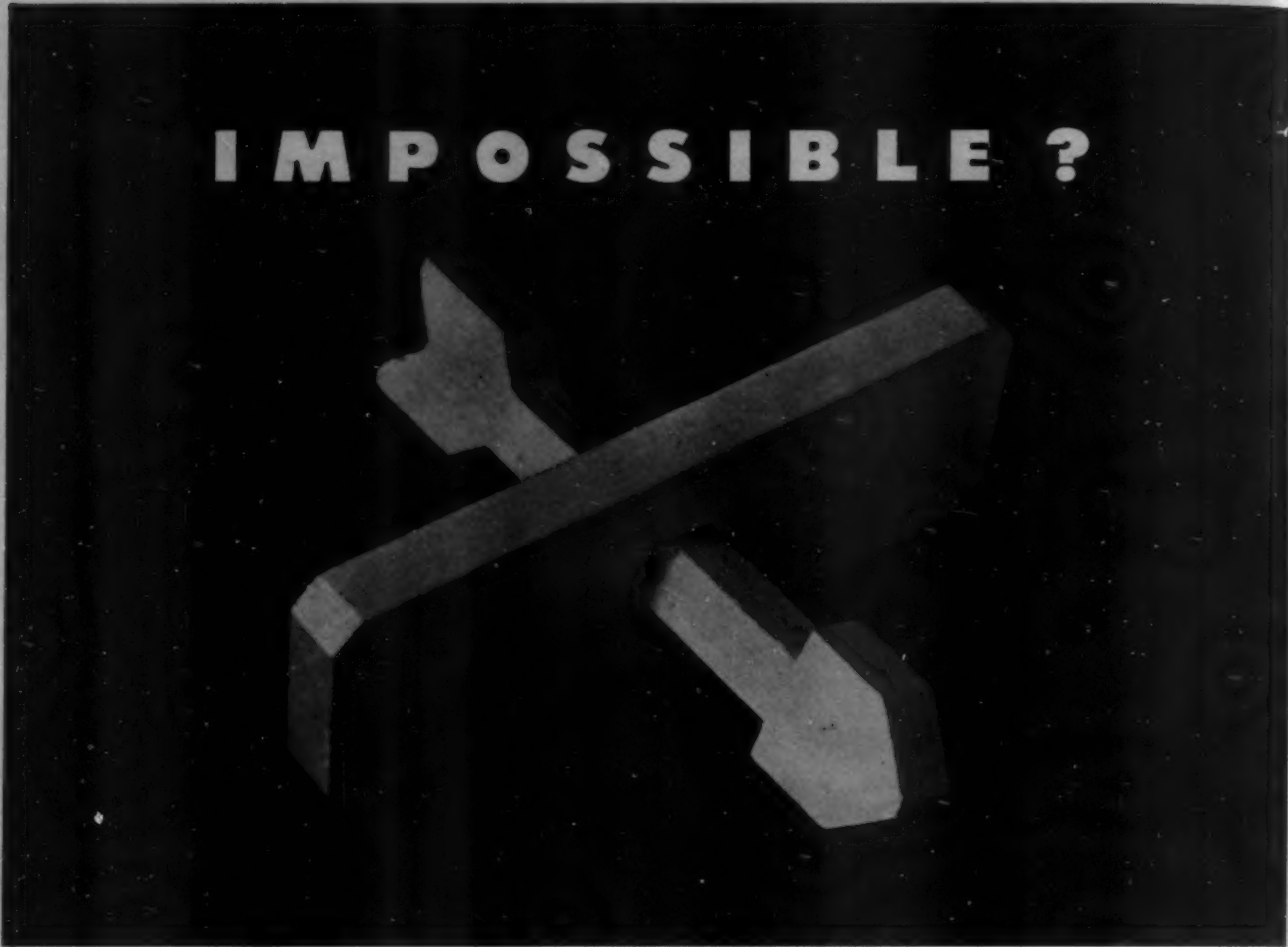
UNIVERSAL PLASTICS

CORPORATION

New Brunswick, New Jersey

CUSTOM MOLDERS

NEW YORK: 12 E. 41st Street • PHILA.: Paragon Sales Co., Inc. • CHICAGO: Steel Mill Products Co. • DETROIT: June & Company



OF course it's impossible. Nobody but a gremlin could have put the arrow through that block of wood, because the ends are bigger than the hole. But there it is, an accomplished fact—and there's a perfectly simple explanation for it.

A few years ago nobody dreamed it would be possible to make the operation of a platen press completely automatic. But today, thanks to the Taylor Flex-O-Timer, it's an accomplished fact. All you do is load the press and push the button. The press closes, steam is admitted to the platens, and at the end of the molding period, steam is shut off and water turned on for automatically timed cooling. And after predetermined cooling, the water is shut off and the press opens automatically for unloading!

We're proud of this Taylor Flex-O-Timer. But we're equally proud of other "impossible" jobs which Taylor "know-how" has been able to work out. Such as Taylor Accuratus Tubing for mercury-actuated thermometers, which gives you accurate reading with long lengths of tubing regardless of ambient temperature variations. Or the Taylor Thermospeed Separable Well Tube Systems. Or the Taylor Fulscope Controller and its recent development, the Taylor Fulscope Time Schedule Controller. And last but not least, the new Taylor Aneroid (mercuryless) Manometer for flow and liquid level.

If you have a tough problem, we'd like to try to solve it for you in a hurry. If, as they say in the war plants these days, it's impossible it may take a little longer. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording, and controlling temperature, pressure, humidity, flow, and liquid level.*

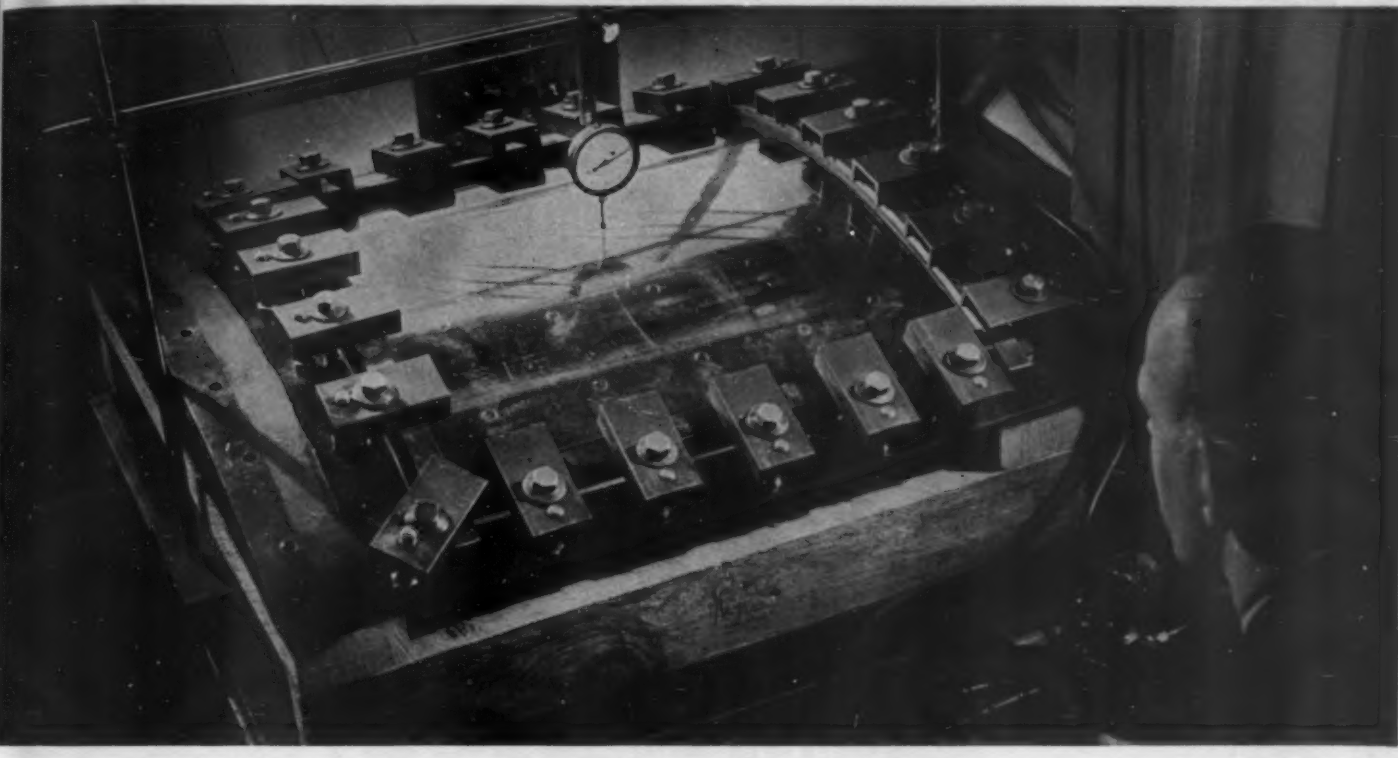
Taylor Instruments

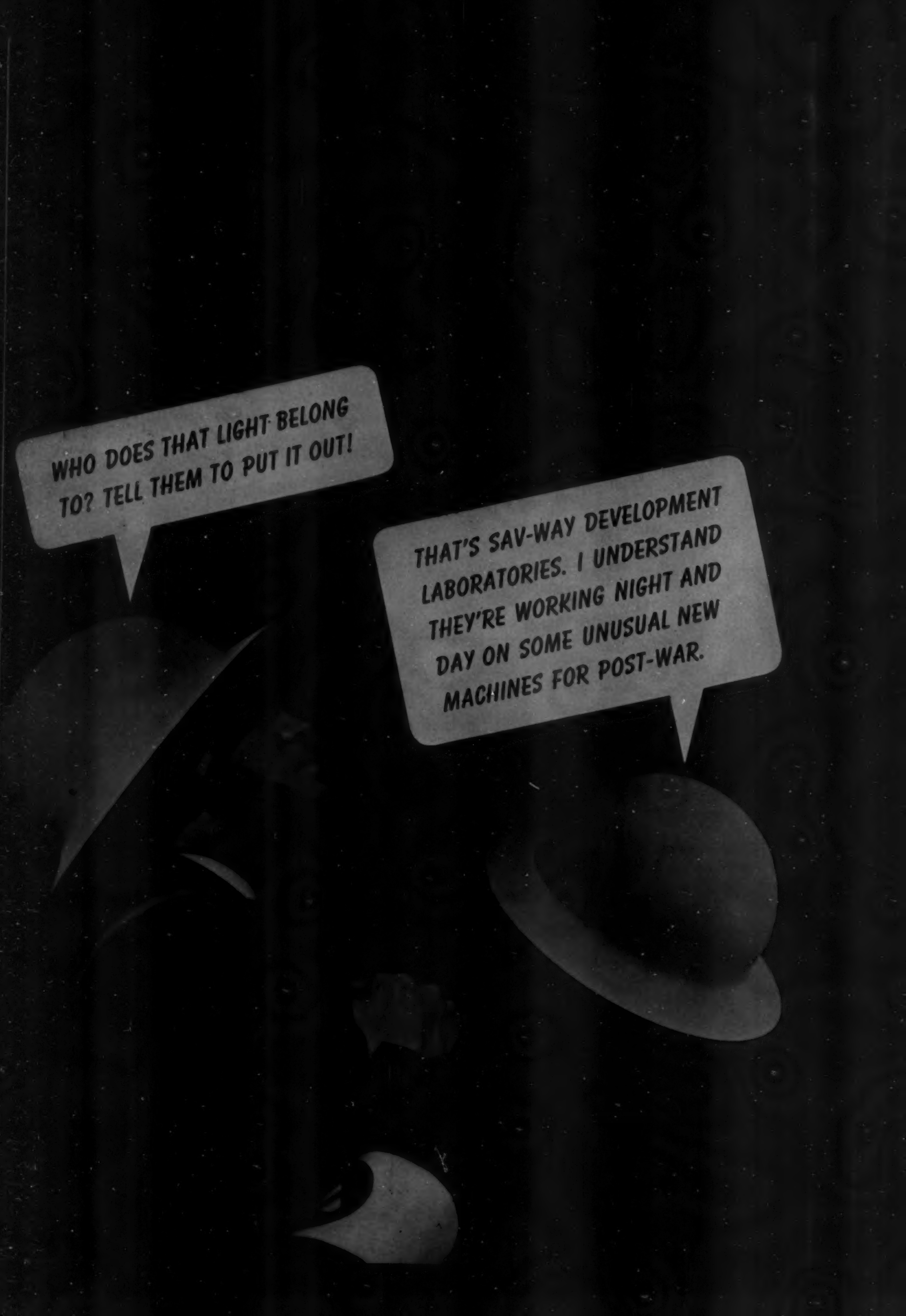
MEAN

ACCURACY FIRST

IN HOME AND INDUSTRY

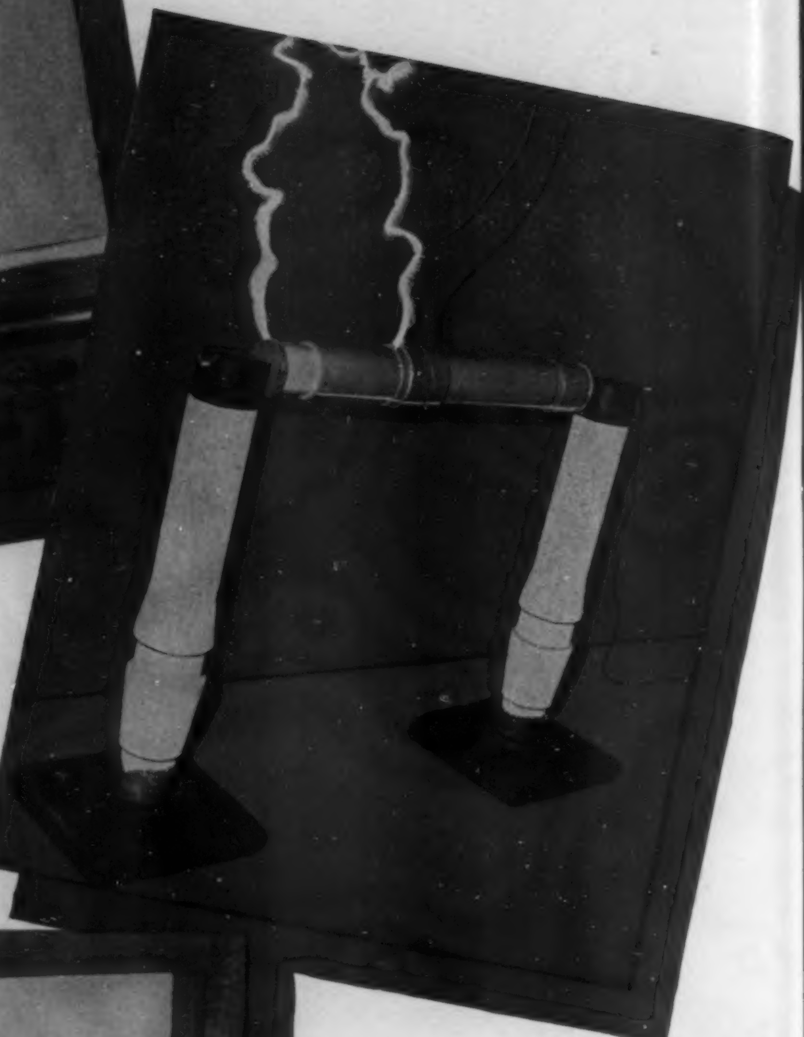
★ KEEP ON BUYING U. S. WAR BONDS AND STAMPS ★




WHO DOES THAT LIGHT BELONG TO? TELL THEM TO PUT IT OUT!
THAT'S SAV-WAY DEVELOPMENT LABORATORIES. I UNDERSTAND THEY'RE WORKING NIGHT AND DAY ON SOME UNUSUAL NEW MACHINES FOR POST-WAR.


Keep an Eye On
Sav-way INDUSTRIES
4875 EAST EIGHT MILE
DETROIT, MICHIGAN
Representatives throughout U. S. A. and Canada

. . . C-D's CUSTOMERS G



YES, DILECTO like all organic materials will BURN, BUT our Research Engineers can give you the exact time in seconds required to ignite this versatile insulating material. Complete details also may be found in the ASTM Standards.

DESIGNED for 15 KV . . . REQUIRES 52 KV to CAUSE FLASHOVER. Shown above is a Dilecto Oil Circuit Breaker Bushing for indoor use. While intended for a breaker of 15 KV, 1200 Amp. rating, specifications called for no flashover between mounting collar and terminals at a voltage under 50 KV. C-D Engineers made certain it took 52 KV to cause flashover.

At left is a precision instrument for measuring the power factor and dielectric constant of solid dielectrics. Every grade and thickness of Dilecto gets a control check on this device.

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GET THE ANSWERS

• In one of America's most complete research laboratories a staff of specialists in both electrical and physical insulation devote their skills to finding out "What happens?". Their reports and recommendations are passed on to manufacturers so that they can accurately predetermine the performance of their products, enabling them to save time and money, and build prestige.

Continental-Diamond's engineers are working *now* on "The Shapes of Things to Come". If you are planning on product improvements that might be speeded by the use of a C-D NON-metallic we suggest that this is the time to avail yourself of C-D facilities and experience.

●

C-D PRODUCTS

DILECTO   A laminated plastic. High in electrical insulating properties. Of great structural strength. Resistant to moisture to a high degree. Readily fabricated to special shapes from basic standard forms of sheets, rods and tubes.

DIAMOND VULCANIZED FIBRE is a hard, dense, bone-like material . . . tough, pliable and strong. It is light in weight yet mechanically strong and will not deteriorate under constant mechanical strain.

MICABOND   Here is mica in its most usable form. The high heat resistance of mica and its high dielectric strength are almost completely preserved in MICABOND plate, flexible sheets, tape, tubing and punched and formed parts.

VULCOID   A product of Continental-Diamond's manufacturing experience and laboratory research. A material that offers a combination of the properties of Dilecto and Diamond Vulcanized Fibre.

CELORON   A molded mascerated fabric base plastic that is also readily machined. CELORON combines to a high degree the desirable properties of impact strength, tensile strength, dielectric strength, moisture resistance, heat resistance and dimensional stability.

●

The above photograph shows a conventional hat molding press being used for experimental molding of laminated materials, at low pressure. The part which has just been removed from the mold is a low pressure phenolic laminated aircraft engine baffle.

How to PREVENT THIS SABOTAGE to Your Screw Driving Army

PHILLIPS SCREWS END DRIVER-SKIDS!

Caught in the act by the "frozen" action photography* of Gjon Mili, is a skidding screw driver . . . one of the meanest of saboteurs. Skidding drivers cause accidents that keep all too many workers away from assembly lines, nursing gouged hands. And, fear of such injury slows-down the work of countless others. Always present, the danger increases with rushed, inexperienced workers. So, it's doubly important today to specify Phillips Recessed Head Screws . . . which prevent driver-skids!

Automatic centering of driving force in the scientifically designed Phillips Recess eliminates all other screw driving troubles: the fumbling, wobbly starts . . . re-driving of slant-driven screws . . . removal of broken-head screws . . . reclaiming of marred parts. Fast, faultless driving becomes automatic, even for "green hands". Power driving becomes practical.

They cost less to use! Compare *driving* costs. You'll find that screw *price* is a minor part of total fastening expense . . . that it actually costs less to have the advantages of the Phillips Recess.

**Gjon Mili synchronizes exposures with lightning-like flashes of the stroboscopic light, to make skidding driver appear to stand still.*

KEY TO FASTENING SPEED AND SAFETY

The Phillips Recessed Head was scientifically engineered to afford:

Fast Starting – Driver point automatically centers in the recess . . . fits snugly. Screw and driver "become one unit." Fumbling, wobbly starts are eliminated.

Faster Driving – Spiral and power driving are made practical. Driver won't slip out of recess to injure workers or spoil material. (Average time saving is 50%.)

Easier Driving – Turning power is fully utilized by automatic centering of driver in screw head. Workers maintain speed without tiring.

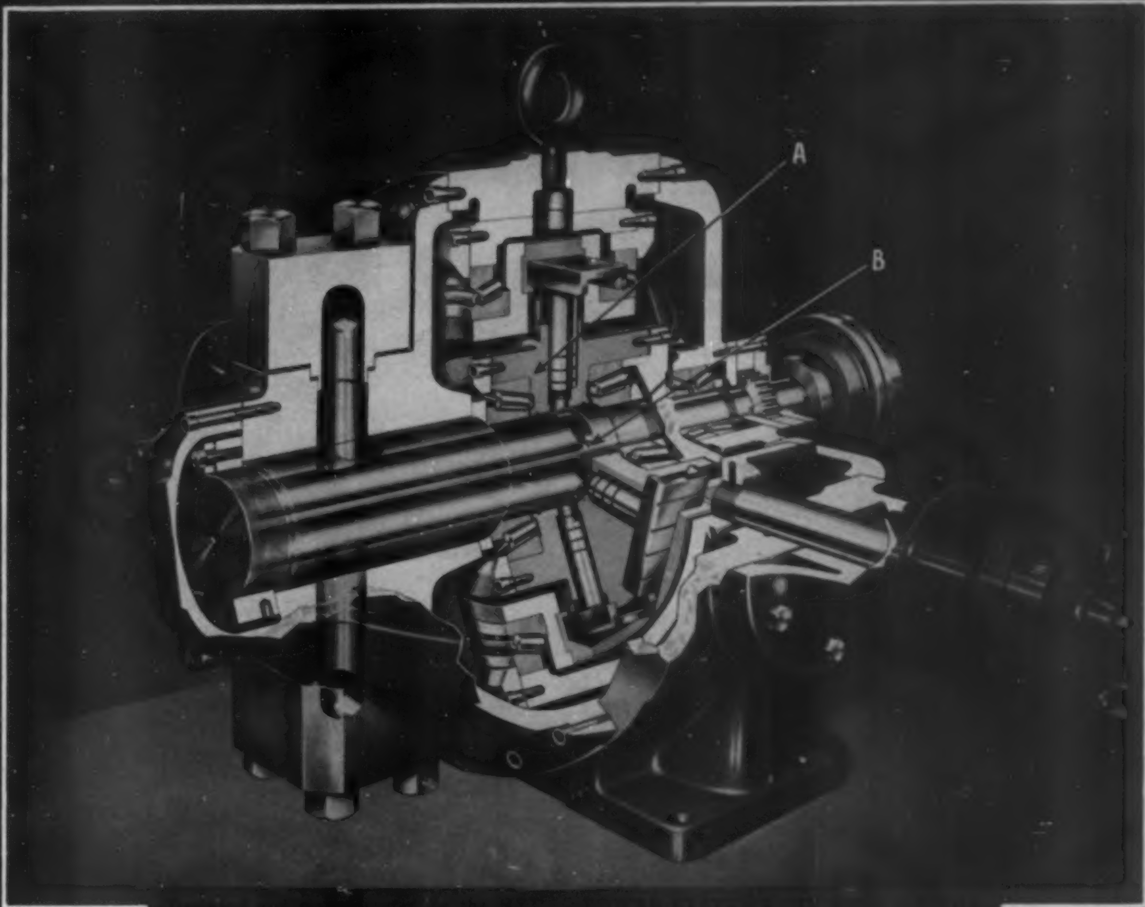
Better Fastenings – Screws are set-up uniformly tight, without burring or breaking heads. A stronger, neater job results.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS SELF-TAPPING SCREWS • STOVE BOLTS

21 SOURCES

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.



DEPENDABLE POWER FOR HYDRAULIC PRESSES *with the* H-P-M TIMKEN BEARING EQUIPPED PUMP

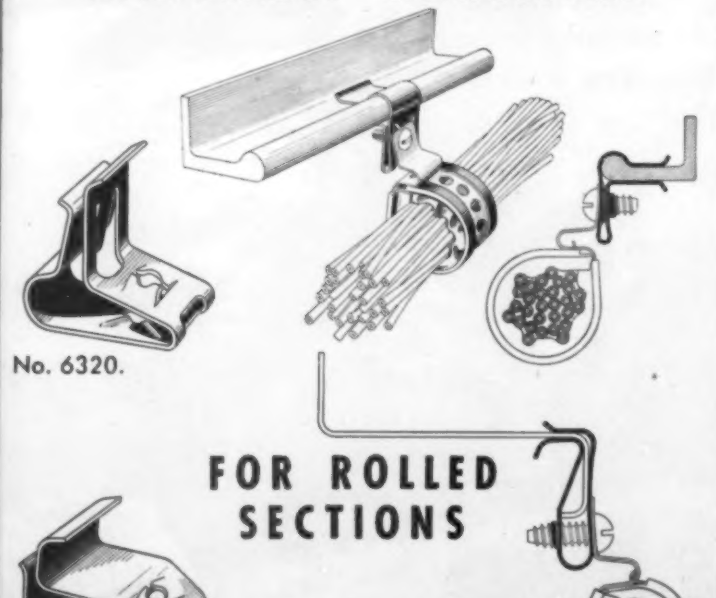
Above is shown a cut-away view of the latest model H-P-M HYDRO-POWER Radial Hydraulic Pump—dependable source of power for presses and all kinds of hydraulically-operated machines. These pumps are noted for long service at high and constant volumetric efficiency. This depends upon maintenance of precision relationship (minute working clearance) between the high-speed rotor (A) and stationary valve pintle (B). Should these parts be permitted to get out of alignment or contact each other, the efficiency and life of the pump would be greatly reduced. To prevent such possibilities, both the rotor and the valve pintle are mounted on Timken Tapered Roller Bearings of extreme precision. This assures preservation of the original operating clearance; freedom from rotor friction; and full protection against radial, thrust and combined loads—therefore greater endurance. Furthermore, should a slight amount of wear develop after years of continuous operation, the bearings can be adjusted with hair-splitting accuracy without dismantling the pump or even removing it from the machine. The Timken Roller Bearing Company, Canton, Ohio.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS


A World of Uses for
MILLS PLASTIC
Tubing
and
Fittings
● From laundry equipment to oil lines, from refrigeration systems to panel boards for recording instruments, MILLS PLASTIC* tubing and fittings have become more and more popular for war, industry, domestic and commercial uses. The unusual characteristics and qualities of MILLS PLASTIC have made it of strategic importance today.
MILLS PLASTIC tubing is a proven practical product because of its adaptability under high bursting and working pressures, insulating qualities, resistance to most chemicals, flexibility and ease of handling. It has replaced vital materials needed in the war effort, such as aluminum, brass, copper, nickel and stainless steel.
MILLS PLASTIC tubing is available in outside diameters of 1/8", 3/16", 1/4", 5/16", 3/8", 7/16", 1/2", 5/8", and 3/4" in a variety of wall thicknesses. Special sizes upon request.
*Made of Saran
For more information about MILLS PLASTIC tubing and fittings, write on your letterhead for the new six-page circular or for our larger catalog containing data and illustrations of Injection Molded and Extruded Plastics.
MILLS PLASTIC
TUBING FITTINGS
STICS
Elmer E. Mills Corporation
Molders of Tenite, Lumarith, Plastacele, Fibestos, Lucite, Crystallite, Polystyrene, Styron, Lustron, Loalin, Vinylite, Mills-Plastic, Saran and Other Thermoplastic Materials
812 WEST VAN BUREN STREET • CHICAGO, ILLINOIS

with Design Changes

FOR BEADED EXTRUSIONS



Rapid changes in aircraft designs are promptly met with new SPEED NUTS engineered to fit the needs of the hour. The Speed Nut principle lends itself to a flexibility of design possessed by no other fastening.

For example: To meet the need for better and faster fastenings on beaded extrusions, up comes SPEED NUT No. 6320. No more holes to drill—no structural weakening. Just snap it on and turn the screw. For attaching conduit, piping, and wire harnesses, it's a record breaker! Again, with the present rapid conversion to rolled sections, SPEED NUT No. 6337 is doing the same record job on "Z" stringers. Hundreds of different Speed Nut designs already have saved millions of man-hours. Calling out SPEED NUTS for MORE of your non-structural attachments will do the same for you. First step is to send us your details today.

TINNERMAN PRODUCTS, INC.

2048 Fulton Road, Cleveland, Ohio

IN CANADA: Wallace Barnes Co., Ltd., Hamilton, Ontario
IN ENGLAND: Simmonds Aerocessories, Ltd., London

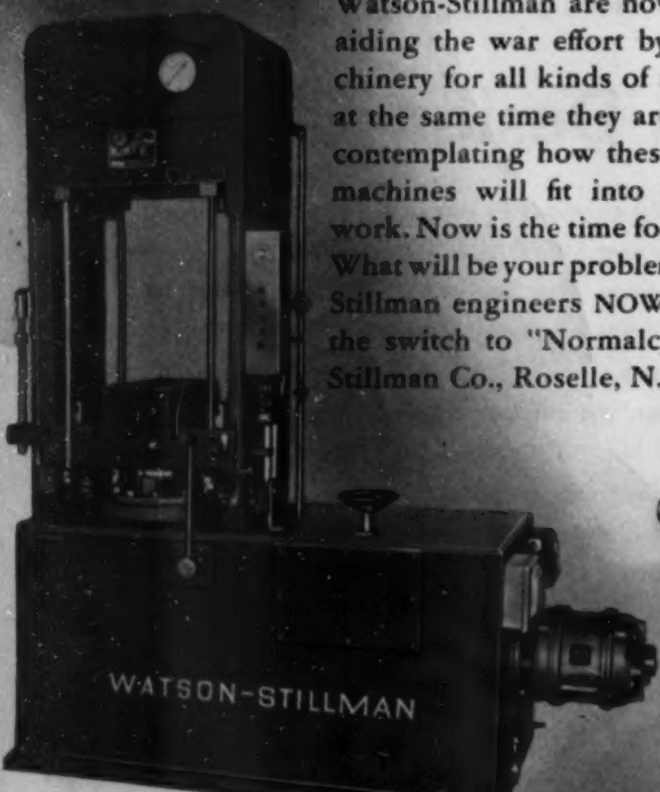
Speed Nut System

—FASTEST THING IN FASTENINGS

BACK TO NORMALCY

ALMOST twenty-five years ago President Harding coined the word "Normalcy." He referred to that phase of the business recovery period following World War I. There will be another such period after World War II. Will you be ready?

The entire engineering and production staffs of Watson-Stillman are now engaged exclusively in aiding the war effort by building hydraulic machinery for all kinds of specialized war jobs. But at the same time they are looking to the future—contemplating how these new and more efficient machines will fit into post-war reconstruction work. Now is the time for you, also, to look ahead. What will be your problems then? Consult Watson-Stillman engineers NOW, and be prepared when the switch to "Normalcy" begins. The Watson-Stillman Co., Roselle, N. J.



Shown here are three of the popular models of Watson-Stillman injection molding machines. The full line is described and illustrated in detail in Bulletin 620-A. Send for your copy NOW.

WATSON-STILLMAN

Hydraulic Equipment, Valves, Forged Steel Fittings

For Victory ★★★ Let's all be Scrappers

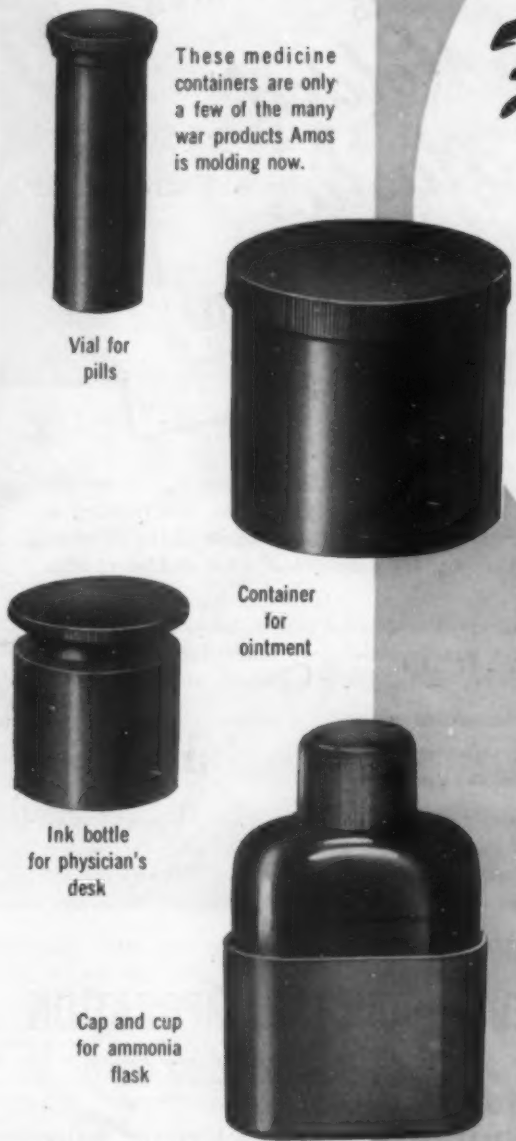
BE READY FOR

Fast Production

OF MOLDED

PLASTICS

AFTER THE WAR



These medicine containers are only a few of the many war products Amos is molding now.

Vial for pills

Container for ointment

Ink bottle for physician's desk

Cap and cup for ammonia flask

We're running three eight-hour shifts a day—producing many different molded plastic products for war. But any day now, an Amos engineer can begin to help you on the design and development of what you want in molded plastics after the war.

Be prepared when war contracts are cancelled. Be ready for fast production of the molded plastic parts or products you'll need in your post-war program. We can help you with your planning and development work now—so you'll be ready at the right time.

Amos

MOLDED PLASTICS

AMOS MOLDED PLASTICS, EDINBURGH, INDIANA

Division of Amos-Thompson Corporation

Custom Molders of all Thermoplastics by Injection Process

"Megger" Insulation Tester, produced by James G. Biddle Co. of Philadelphia. Hand-cranked generator makes unit instantly available under any conditions. Resistance is shown by direct reading ohmmeter. Plastic housing is rugged and dependable.

Above, you see the sleek new "Megger" housing assembly . . . a success story in the use of molded plastics. Replacing aluminum, this housing is lighter, completely corrosion proof, and costs less (because of the elimination of considerable machine work). It's a sample of *what* molded plastics might do for you.

But that's only half the story! The detailed photos below illustrate not *what* but *how*: How to achieve equally satisfactory results for your plastics application. They demonstrate two truths that are axioms in our business:

1. **Satisfactory results are impossible without good design.**
2. **Cooperation with the development engineers of a good custom molder produces the most satisfactory designs for plastics.**

Working with Biddle Company's product designers from the inception of their plans, our development engineers were able to contribute substantially to the success of this application. We maintain a separate department for this service alone. Would you like to have it at your disposal? No obligation . . . just write!

DESIGN DETAIL—Bezel and hinged cover are produced in only two parts, without the use of metal. Thu flexibility of the bezel (molded of cellulose acetate butyrate) permits it to be bent slightly for easy assembly. When attached to the case, it is held rigid, forming a substantial hinge which holds the cover securely.

Plastic parts of the case for this new "Megger" Tester are compression molded of impact-resistant phenolic material.

CHICAGO MOLDED PRODUCTS CORPORATION
Precision Plastic Molding
1046 NORTH KOLMAR AVENUE ★ CHICAGO, ILLINOIS
COMPRESSION, INJECTION AND TRANSFER MOLDING OF ALL PLASTIC MATERIALS

● It was not long ago that you were making automobiles, radios, household appliances and the thousand and one things that contributed to the American standard of living; and we were supplying many of the molded plastics parts to make your products more efficient, better looking, and more valuable.

Today all of us are devoting our facilities to Victory production. We can let nothing interfere with this all-important job.

Tomorrow we shall be equipped to work with you and for you with the greatest efficiency in the production of molded plastics to help reconstruct a finer and better world where men and women may enjoy in peace the many things that invention has in store for them.

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MOLDED PLASTICS

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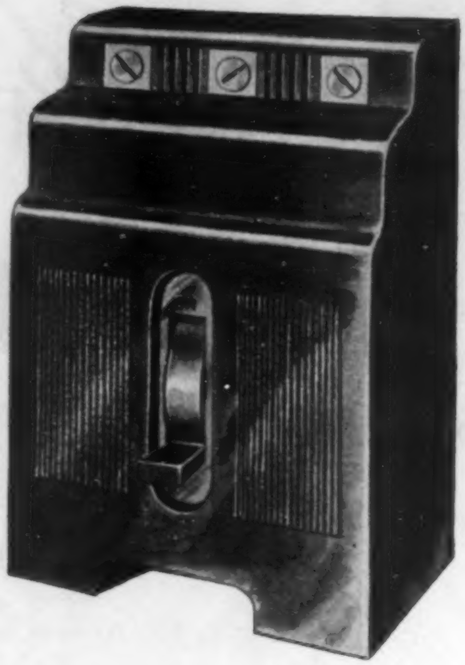
NEED SHOCK-RESISTANCE? THIS NEW MELMAC FOR SEVERE SERVICE OFFERS UNUSUAL PROPERTIES!



CIRCUIT BREAKERS and other electrical parts molded of Melmac combine shock-resistance with flame and arc-resistance, dielectric strength, heat resistance.

Here's a *third* type of MELMAC* developed in Cyanamid's Research Laboratories to really "take it"! Known as Melmac P-3020, this new thermosetting melamine-formaldehyde material is chopped cotton fabric—filled for *high strength*. And in addition, it has the same exceptional characteristics that have earned an important place in industry for other Melmac plastics—high dielectric strength, high arc-resistance, flame-resistance, and excellent durability.

Perhaps Melmac P-3020 can improve *your* product. Natural (mottled white) and black Melmac plastics are available on preference ratings for essential use. Just drop us a line for further information and data sheets. For future planning, we will be glad to send you test samples of Melmac P-3020.

IN HEAVY DUTY TELEPHONES, the high shock resistance and flexural-strength of Melmac P-3020 combine with other properties to meet the most severe service conditions, contribute to long life.

AMERICAN CYANAMID COMPANY
Plastics Division
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MODERN PLASTICS

JUNE 1943 VOLUME 20 NUMBER 10

Custom converter

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A new factor in the U. S. plastics industry is a firm which supplies laminators and molders with materials treated to definite specifications under strict laboratory control

A NEWCOMER to the American industrial scene is the custom converter of plastics materials—a concern which manufacturers no end-products, but devotes itself to plastic impregnation of paper and cloth on an economical volume basis to the specific requirements of laminators and molders which it supplies.

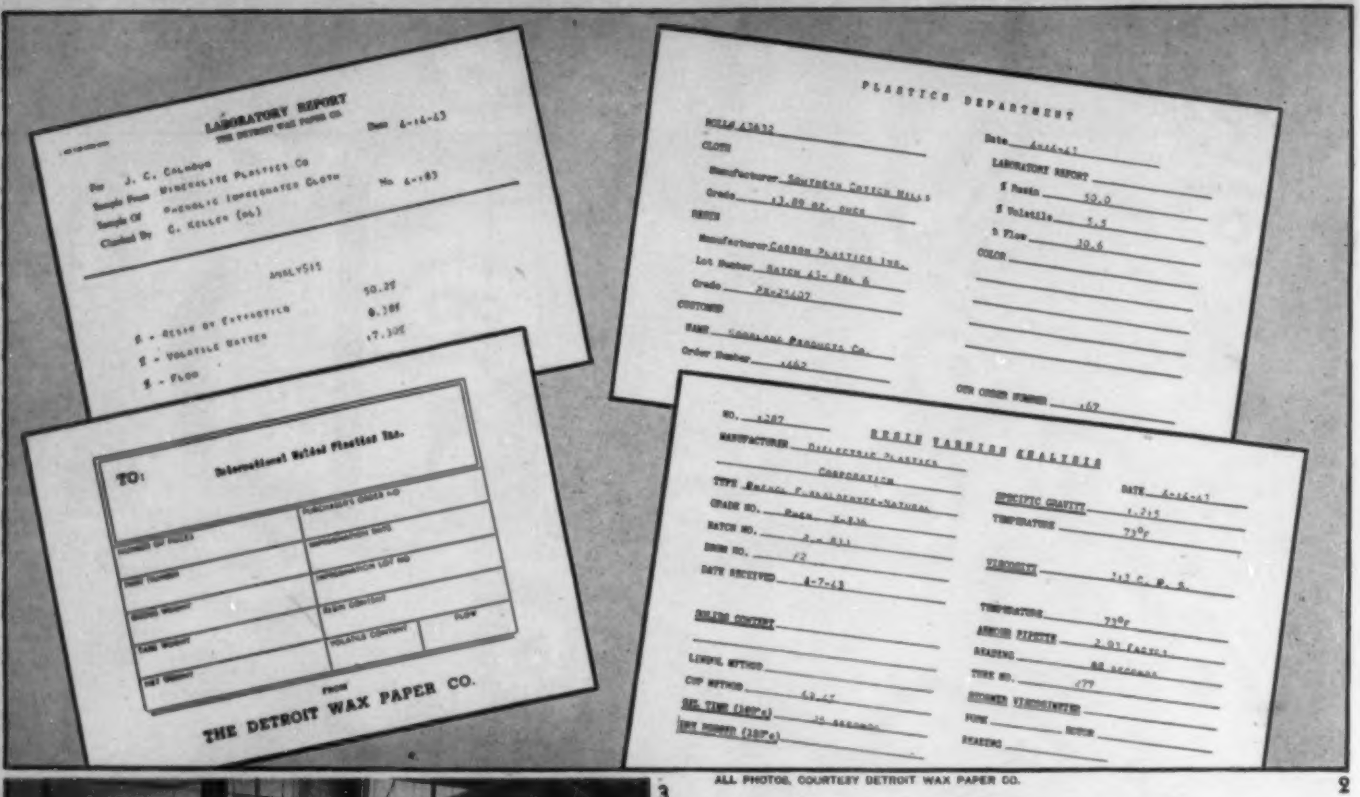
Such concerns play a definite rôle in the plastics industry of Great Britain, but the first to develop the idea on any scale in this country is the Detroit Wax Paper Co., a neat little factory down-river from the motor metropolis, which until two years ago was busy making bread wrappers and had never dipped a ladle in a barrel of resin.

Today this company supplies to some two-score plastics product fabricators the raw materials for a dozen of the most important laminated war items, and through its own ingenuity has suggested such significant new departures as a paper oil-and-fuel filter element which is actually superior to brass. It has been a leader in the development of commercial material for low-pressure molding by the hat press, rubber bag and autoclave methods.

Based on its experience in the treatment of paper, the company sees in the plastic-paper combinations an entirely new outlet for plastics. It believes that, with due appreciation of their physical properties, plastics in the future will become prime engineering and structural materials. And it thinks that it is on the right track in working along these specific lines with paper and fabric reinforcement.

This company is in a strategic position to work with the automobile industry on structural plastics, and it is making itself valuable by keeping in step with the new techniques and new materials, as yet unpublicized, which have been born of the war. New materials include several new resins, new base materials and new adaptations of some of the older standard resins. When associated with new techniques such as the jet molding process, low-pressure molding and heatronic molding, these developments take on much significance. It is generally agreed in Detroit that recent developments leading to better physical properties, durability, heat insulating qualities and strength-weight factor have made plastics a certainty in the coming development of a lightweight, economically operated automobile. The supplying of plastic-impregnated materials to the automobile industry may well become big business.

Frequently the company analyzes and duplicates a sample of material submitted by a customer. Figure 2 illustrates a typical laboratory analysis of a sample of impregnated material presented by a customer for duplication. With each roll or lot of treated material shipped to a customer there goes a detailed laboratory report showing its exact resin content, volatile content and flow, which serves as a



ALL PHOTOS, COURTESY DETROIT WAX PAPER CO.

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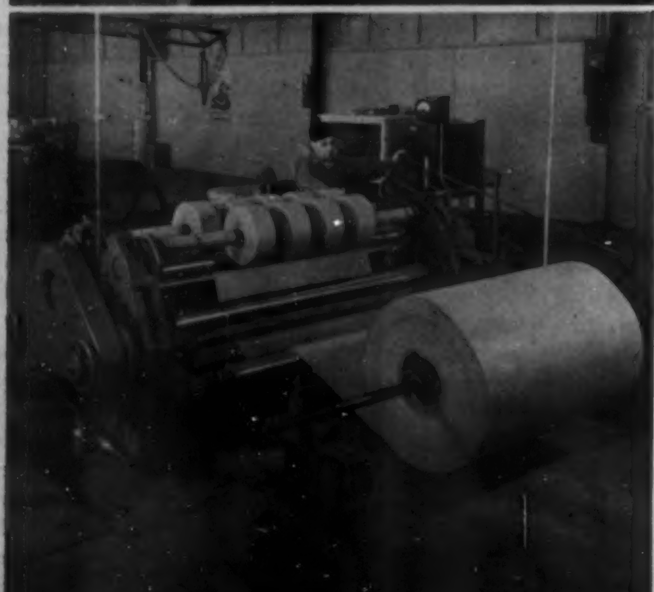

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foolproof guide in the molding room and minimizes waste, scrap and rejects. These figures are not taken for granted, but are determined by separate analysis of each roll of material.

To maintain this strict standard, all raw materials are analyzed as they come into the plant. For example, a quart of resin is taken from every barrel, sent to the laboratory, and a regular routine report issued. Then, after the material has been treated with the resin solution, samples are cut from each roll and analyzed to determine whether the desired formula has been achieved. A typical roll record is also shown in Fig. 2. Plastic impregnating solutions are mixed and colored in a standard kettle-type mixer with low-speed stirring equipment. A basic phenolic resin is used, and to it is added a catalyst, dyestuff, thinner, lubricant, plasticizer, accelerator and sometimes other resins.

The converter is a specialist, and as such has the advantages usually to be found in specialization. His equipment is larger and more efficient than any which could be maintained by the average molder or laminator merely for impregnation purposes. This equipment operates continuously at a high rate of speed, and thus effects economies that could not be obtained by the molder treating his own material. And —most important for the war effort—the molder, who is thus relieved of the space and time-consuming job of treating his own materials, is enabled to step up appreciably his output of finished war materials.

Equipment

Key equipment in the company's plant is an enormous two-zone impregnating machine (Fig. 1), 114 ft. long and about 20 ft. high, through which move fabric or paper webs up to 50 in. in width. Custom built in the plant, this unit includes mechanical equipment and drying ovens. It is the only impregnator of its type with an overhead oil-fired heater. The impregnator is of the forced-air circulation type, and is completely equipped with thermostatic controls in both zones and thermostatically operated dampers in the

main zone ducts. Small doors along the side are equipped with safety latches in case of an explosion of the highly volatile material. Every material produced by the plastics department, regardless of the wide variety of end uses, moves first through this impregnating machine.

Rolls of paper or cloth are fed into the long machine on a continuous basis (Fig. 3). A single run of material sometimes lasts as long as 48 hr., with rolls being stitched together to provide a continuous web. In this "squeeze roll" method of treating material, the untreated fabric dips into a bath of phenolic solution at the machine's loading end and is then squeezed through rollers to the desired resin content before entering the long oven through which it progresses at the rate of 23 ft. a minute at 285° to 295° F., as against a maximum of $7^1/_2$ ft. per minute by the usual dip and flow impregnation method. As the material emerges from the rewind end of the impregnating machine, it passes over a cooling arch through which cold water circulates to stop the curing abruptly. As finally wound on rolls, the material is at room temperature. A standing floor fan near the rewind end also helps to cool and clear the material.

Rolls of impregnated material are shipped full width, slit to specified widths, or sheeted for die cutting. Large rolls are slit and rewound into smaller rolls on a Cameron duplex slitting machine (Fig. 4). Other equipment cuts the treated papers and fabrics into sheets of various sizes. When special forms or segments such as patterns for helmet liners are specified, roll-feed, die-cutting presses (Fig. 5) are employed.

Recently the company has installed two low-pressure hydraulic hat presses (Fig. 6) to further its own experiments in the new field of low-pressure molding. By such research it has been able to determine very exactly the percentages of resin, volatile and flow best suited to this form of molding, and the formula which it recommends has been adopted by a number of leading producers of helmet liners, connector boxes, etc.

In all, the company supplies some 30 concerns now using the low-pressure (150 to 200 p.s.i.) method of molding. Most active in this field are some of the large hat manufac-

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2—Samples of laboratory reports sent to customers (names are fictitious). 3—In the "squeeze roll" method of impregnation, cloth or paper is dipped into resin solution, squeezed through rollers to desired resin content. 4—Cameron slitter subdivides large rolls of paper. 5—Roll feed press die-cuts segments of resin impregnated cloth for helmet liners. 6—Low pressure hydraulic hat presses are used for research and development. 7—Steel-rule die for helmet liner segments is of spring construction to regulate precise depth of cut. 8—Helmet liner scrap is baled, shipped to molders of small articles

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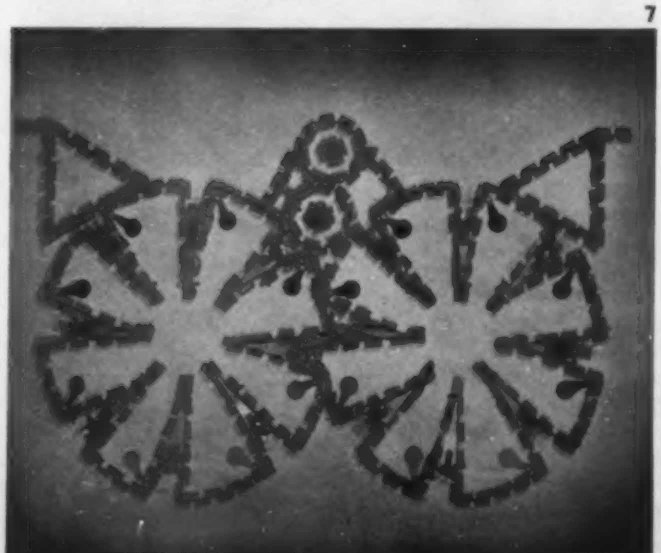

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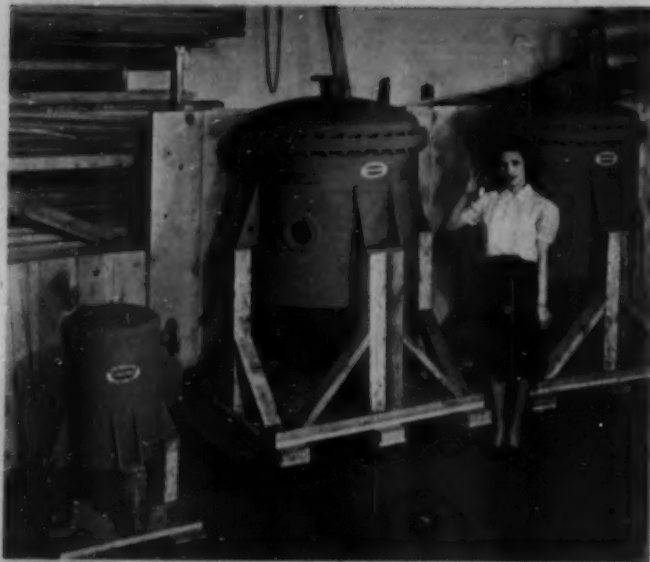
PHOTO, COURTESY SKINNER PURIFIERS, INC.



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turers. The low-pressure process, aside from the fact that it opens up a large and previously untapped field having existing equipment, has the virtue of low cost. It uses cast aluminum dies at a cost of approximately $90, as against $2000 for the usual steel die. While special resins have been developed to make low-pressure molding feasible, the Detroit firm has worked out a special impregnation formula which provides 54 percent resin and a very high flow and volatile.

Aside from the nominal cost of the equipment required, airplane parts obtainable from impregnated cloth using the low-pressure molding method are claimed to be superior to metal in some respects. It is possible to mold varieties of compound curves which would be difficult to obtain with metal. The cloth parts are reported to be cheaper than metal parts and, weight for weight, equal in strength to aluminum.

Low-pressure molded applications

Helmet liners. For the production of cloth for helmet liner segments, the converter developed the special steel-rule dies (Fig. 7) which are used on the roll-feed press for cutting these parts. The die is of a spring construction to give the exact depth of cut desired. The press (Fig. 5) operates at the rapid pace of 500 impressions an hour—much faster than the conventional cutter. Each impression cuts from a square of cloth a pattern which includes one inside preform and one outside preform and two squares which form the complete helmet liner. Preparing helmet liner material is an exacting impregnation job, in that there must be close control of the volatile and the amount of hardener so that when the die-cut shapes are molded together there will be the right amount of "lap flow."

Filters. One of the most interesting developments in which the converter has played an important part is the use of phenolic-impregnated paper in piled form to provide a superior element for all types of filter. These filter cores range in size from a midget weighing approximately 2 oz., for filtering the de-icing fluid in (*Please turn to page 152*)

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9, 10—Phenolic impregnated paper cores serve filters of all sizes. 11—Airplane parts molded by low pressure. 12—Fuel filter with brass (right) and paper filter elements

PHOTO, COURTESY AC SPARK PLUG DIV., GENERAL MOTORS CORP.

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SPI *Annual* SPI

SPRING CONFERENCE

GEORGE K. SCRIBNER
PRESIDENT, S. P. I.

RECOGNITION of plastics' wartime achievements and a forecasting of their tremendously expanding rôle in the industrial era to follow "unconditional surrender," were the themes of the Annual Spring Conference of the Society of the Plastics Industry, held May 13 and 14, at the Edgewater Beach Hotel, Chicago, Ill. There was a record attendance of over 750 at the meeting. Representatives from the Armed Services, from Government bureaus and agencies were present as well as plastics manufacturers, molders, fabricators, extruders, material suppliers, machinery and tool makers, and designers, from the United States and Canada.

Crammed with important and interesting sessions that covered a wide range of subjects, the Conference clearly indicated how well the plastics industry has mobilized its resources for wartime production, and how it plans to employ the experience thus gained in the postwar economy. New materials and techniques described at the various sessions provided added stimulus to this postwar trend, and the tenure of discussions at the sectional meetings showed the industry's awareness of what it can and must accomplish. Lectures on current problems arising out of wartime production helped round out the Conference. A complete report of the meeting is presented in these pages.

At the Luncheon Session, S. P. I. officers for the new year were elected as listed below:

President and director: George K. Scribner, Boonton Molding Co.; vice-president and director: Howard Bunn, Union Carbide & Carbon Co.; secretary-treasurer and director: H. H. Wanders, Northern Industrial Chemical Co.; chairman of the board and director: Ronald Kinnear, Niagara Insul-Bake Specialty Co.; directors: Horton Spitzer, Plaskon Div., Libbey-Owens Glass Co.; William Joslyn, E. I. du Pont de Nemours & Co., Inc.; James Neal, Norton Laboratories, Inc.; W. M. Phillips, General Motors Corp.; J. D. McDonald, McDonald Mfg. Co.; O. W. Marsh, General Industries Co.; M. C. Milliken, Hercules Powder Co.; F. A. Morlock, Durite Plastics, Inc.; Carl Hitchcock, Farrel-Birmingham Co., Inc.; J. McCortney, Chrysler Corp.; Canadian representative: A. E. Byrne, Canadian General Electric Co.

AT THE opening session on Thursday, May 13, William T. Cruse presided. Ronald Kinnear, president of the society, congratulated the Chicago committee on their smooth job of organization. The committee was headed by Elmer E. Mills, general chairman, and R. B. Harrison, Chas. C. Livingston and J. E. Johnston, committee chairmen. Mr. Kinnear then reviewed the activities of the S.P.I. during the year, reporting on the expansion of the society, which now has 264 company members and 476 individual members and an income of $44,806 for the fiscal year, June 1942–1943. Mr. Kinnear described the activities of the Technical Committee and the Bulletin Committee, the work done with WPB to compile a list of idle injection machinery and the compilation of financial statements of molders in order to help the industry establish a basis for renegotiation of war contracts. He also announced that the Molders Committee (not part of S.P.I. but clearing through it) still was functioning under the direction of Allan Fritzche, chairman. Mr. Kinnear concluded with a patriotic appeal to the industry to pledge its efforts, knowledge and experience toward a quick termination of the war

Robert C. Crawford, director of development, Durez Plastics & Chemicals, Inc., was the next speaker, delivering a talk on the *Manufacture of Synthetic Phenol* by the Raschig method. Mr. Crawford's speech, which he illustrated with slides, described this vapor phase regenerative chlorination process for phenol production and contrasted it with the older sulfonization and liquid phase chlorination methods which make 2 to 5 lb. of by-products per lb. of phenol. The Raschig method produces less than 0.1 pound. A complete record of this remarkable chemical engineering accomplishment as described by Mr. Crawford may be found in MODERN PLASTICS magazine, November 1940, p. 62.

Dr. Alphonse Pechukas, director of research, Pittsburgh Plate Glass Co., the concluding speaker on the morning program, delivered a lecture on *Allyl Alcohol Resins*, new low pressure thermosetting resins derived largely from petroleum gases. The resins' many unique properties, such as excellent clarity, high abrasion resistance, strength and solvent resistance, have restricted their use to numerous war applications of a classified nature but suggest manifold peacetime prospects. Because of the great interest

in Dr. Pechukas' subject, MODERN PLASTICS is reprinting his talk in full in the Technical Section of this issue, page 101.

At the afternoon session, Chas. C. Livingston presided. After introducing the directors and honored guests at the speakers table, he presented the first speaker of the afternoon, Herbert J. Taylor, vice-chairman, Price Adjustment Board, War Dept. Mr. Taylor's topic was *Re-negotiation of Contracts*, a subject of widespread interest to the industry. A digest of the speech is presented herewith:

The topic I have is Re-negotiation of War Contracts. Some of you can relax and not take any interest in this talk because some of you are not subject to re-negotiation. Any contractor or subcontractor who has less than $100,000 worth of war business during a fiscal year is not subject to re-negotiation. However, all of you who have over $100,000 worth are subject to re-negotiation, and just because we haven't come around to see you yet, don't think you are eliminated. First we take the larger companies, and then we take the ones that come forward and volunteer for the operation. Finally we get down to some of the smaller cases.

To give you an idea of the volume of this work, we have approximately 20,000 contractors to re-negotiate, and the total volume of War Dept. appropriation alone is over one hundred billion dollars. Up to March 31, the total refund in excessive profits from contractors for the War and Navy Dept. and Maritime Commission, has been approximately $2^1/_2$ billion dollars.

Just a word about the philosophy behind this Re-negotiation Act. Re-negotiation of war contracts for this war actually went into effect at the end of the last war, World War I, as a result of the boys' coming back after the war to find that their neighbors and friends had made outlandish profits on war production in the plants in which they worked—that many had become millionaires. These men, many of whom today are members of the American Legion, determined that in the next war there would be no millionaires and no profiteering. From that time on there was a trend in the Congress toward controlling profits on war production. As a result of this feeling and also because Congress was determined to hold inflation under control we have re-negotiation.

R. C. CRAWFORD

The need for re-negotiation or control of profits is more essential in this war than the last war. In the last war, the total expenditures were about 22 billion dollars. World War II appropriations for war purposes are approximately 240 billion dollars, almost 10 times as much as World War I.

The War Dept. Price Adjustment Board, the Navy Board, Maritime Commission and Treasury Dept. are assigned the job of determining what are excessive profits on war production. Many times we have been asked to define excessive profits.

Now, I want to give you at this time my definition of excessive profits. Excessive profit is that profit which neither the Government nor the contractor would be willing or able to defend in a court of public opinion. In other words, coming down to you individually the amount of profits that you wouldn't care to announce to the assembled community is excessive profits.

Now, that's one definition—and we do have to account to the public as you know. We know we have to account to the public because our Boards are continually being investigated by Congress. We got through a short time ago with a thorough investigation by the Truman Committee of the Senate. You know their report was published. Now we are being investigated by the Vinson Committee, and we'll continue to be investigated because the Congress has placed the responsibility on our shoulders to determine what are excessive profits, to see that industry is treated fairly and justly, and that the Government recaptures excessive profits on war operations.

Now, the second definition I want to give you is that of a fair profit. A fair profit is that which the contractor would be willing to announce to the men who have left his plant and are serving in the Armed Forces. You look over your profits for the year. If you would be willing to announce those profits to the boys after they return to the plant and say, "Boys, this is what I made with this capital investment and this percentage on sales while you were in the fighting forces winning this war for us"; if you could announce that, feel that it was a fair profit and think they'd feel it was a fair profit, then that is a fair profit on war production. The amount above that figure would be excessive profits and that is the amount we propose to have refunded to the Government. We arrive at that amount by sitting down with you at individual conferences, and determining it through one or more conferences between the executives of the company and the representatives of the Government.

A. PECHUKAS

Coming down to the reasons for excessive profits the Undersecretary of Navy said that the time lost in placing orders never can be recaptured, while excessive profits made on war contracts can be recovered at a later date. Now, all that the Undersecretary means is this: When Pearl Harbor came, it came suddenly. Immediately we had to buy billions of dollars of armaments. The procurement officers are doing an excellent job. But they didn't have time to go out and get competitive bids; they didn't have time to give a test lot or order to find out how much a tank would cost. They had to do it and do it quickly and in many cases they deliberately made the prices high, because they knew if the contractor would lose money on it, it would slow up production. As a result, there were tremendous profits.

Another thing that wasn't realized when Pearl Harbor came was that sales and profits were going to pyramid through 4, 5, 6, 7, 8, 9, 10 times the production with, in some cases, the same working and invested capital as in peacetimes.

The second reason we have tremendous excessive profits is that we don't have competitive peacetime situations. Someone has said that re-negotiating is the substitute for peacetime competition. As I mentioned before, large corporations like Chrysler, General Motors, and others that have taken on millions of dollars of war production and are making entirely different things than they were making in peacetime, didn't know what their cost would be until they got into mass production. When they did they found they were making 10, 20, 30 percent more than they had contemplated. And that is why we have re-negotiation.

Now, 95 percent of the contractors give us splendid cooperation on re-negotiation. You can't be in this kind of work, seeing a cross section of all American industry without feeling a great admiration for the marvelous job it is doing on war production. Here in a period of one year, you have developed new ideas and products and substitute products that in normal peacetimes probably would have taken you 5 to 10 years to develop–you all know that.

It is a wonderful job, and we want to do what we can on re-negotiations to see that your industry and other industries come out of this war clean and strong because we need to be strong for the competitive situation we are going to be up against when the war is ended. One of our objectives is to bring about greater efficiency, lower cost, higher quality, thus helping to win the war more quickly.

Now, the objectives of re-negotiation. First, to recapture excessive profits; second, to secure lower prices on present contracts; third, to assist in securing lower prices on new contracts.

Price reductions act as a brake on inflation and reduce Government expenditures with a reduction in the taxes you and I must pay to meet the cost of this war. Also they result in a lower cost

of production. If you are making 60 percent profit, there isn't the same incentive to lower cost as there is if you are making 6 or 7 percent profit on a much higher volume. Price reductions result in a release of plant capacity and materials, of machinery and equipment, as well as capital for more war production. They encourage and stimulate efficiency in operation.

Now, I am going to talk to you specifically on re-negotiation and how it works. I am going to take you inside and tell you just how it will be handled in the case of our own company. Some of you already have been re-negotiated, others are just starting, while still others have not commenced.

In the first place, we attempt to arrive at a fair profit on your war production. In the case of certain industries, for example, the brass industry, a number of large companies have been manufacturing the same items for years. We can make a study of peacetime operations, the valleys, the ups and downs, the return on the invested capital before and after taxes, and we can apply the study to your own picture. The same is true in the rubber industry, the machinery and tool industry, the textile industry, etc. And it is true of plastics, except in the plastics industry we have the immediate situation that you are a comparatively new industry.

In order to arrive at what is a fair profit, we naturally look at your performance during what we term the base years. The base years are 1936 to 1939, inclusive. We chose those years because the Congress picked them in connection with the excess profits tax, and consequently you will be asked by the men in your re-negotiating committee to submit your figures from 1936 to the present fiscal year.

Let us say that your base years are from 1936 to 1942. You will have your expense and operating figures for that base period, also your balance sheets. We don't send a flock of auditors out to your plant to get these figures. We use your audited operating statements. It is true that those handling the re-negotiating, the cost analysis people, will get additional facts and information on your operations in the past and present, but they do that in order to be sure that you get a fair and equitable treatment on re-negotiation. Each individual case is handled on a basis of its own merits. In the case of plastics, some of you weren't operating during the base years. You're new companies, many of you, and, therefore, you can't use your operating figures for 1936 to 1939, without taking other figures into consideration.

Now you will say, "Well, if you use the base year that means you won't give these companies any profit at all because they didn't make any money in the competitive peace times, 1936 to 1939." But we do. In these cases we have to set up a norm in line with what is a fair profit for turning out approximately the same production they turned out in peacetime. Let's say it was 10 million dollars, or around 6 to 8 percent. Whatever the figure happened to be for that particular industry, we would go up and down from there depending on the plus and minus factors. The thing we give weight to is what is the final cost to the Government of the item manufactured. Now, if a company produced at a lower cost than their competitors, they're left with a higher margin of profit.

We use the over-all approach when we re-negotiate you for a fiscal year, and we take your entire operations for the fiscal year. We operate from your operating statements and your balance sheets, taking the whole 12-month period. There is an advantage to you in this. If we did it by contracts, you might make a nice profit on one contract, but lose on another. However, by re-negotiating for a fiscal period, it takes up the lowest and the highest and levels it off.

The next thing we do is apply an approach. Let's say during the base year 1936 to 1939 you did a million dollars worth of business—an average of a million dollars a year for the 4 years—and let us say that you made 10 percent profit before taxes for those 4 years. Now let's say you have a million dollars worth of invested capital or a half million dollars. In 1942 because of war production you had 5 million dollars worth of sales instead of a million, and you do it with the same invested capital, just turning it over more times. As we go up on these increments on the first million dollars, you might be allowed the 10 percent from the base years. When you came to the second million dollars you'd be dropped down, because in the same plant, the same working capital, same administrative overhead, you have more dollars of sales, so it is spread over more sales, and, therefore, you can take that extra million dollars at a lower figure and still have a fair profit.

Here are some of the facts to be considered. When you come in for re-negotiation I encourage you to give the complete picture because every item and factor in connection with your performance on war production is weighted and given a certain importance in connection with determining what is a fair profit on what you have done to help win this war.

For example, a truck assembly company with 4 million dollars of capital which in peacetime was required for turning out 10 million dollars a year of trucks, against competition of the Big Three: Ford, Chrysler, General Motors, last year turned out 90 million dollars of trucks for the Government. That was an outstanding job because they didn't get additional working capital. They didn't have 2 or 3 additional plants for it, and didn't get any loans, but they did a very efficient job. They're smart operators, and they were given a very definite plus sign on re-negotiation and a higher margin because they used less plant capacity, less man-hour production, and less capital in turning out what they produced to help the war efforts. So, increased volume with a limited capital and facilities is a plus sign.

Another is prompt delivery. That is, we check your performance. We have these figures available for use, not only in Ordnance and Air Corps but in all the services. We cooperate closely with them in the Procurement Division. Also a man from WPB serves on our Board, one from OPA, the Treasury Dept. and so forth. Once in a while we have to go over to the FBI. When I refer to the Dept. of Justice, I have in mind the fellow with the 13 relatives with $30,000 each.

Coming back to these others factors, the quality of your production is a plus sign, and this probably is given the most weight in every case. It is the final net cost to the Government—in other words, how your prices compare with similar items that the Government is purchasing from you.

H. J. TAYLOR

In other words, let us take a contractor who is producing guns. I happen to know that one contractor produced guns in 1942, and the same gun was being produced in 2 other plants. One price to the Government was $250 a gun; another was $300 a gun; the third was $400 a gun. Well, when we came to re-negotiate these 3 firms, we gave a higher margin of profit to the manufacturer who produced that gun for $250, and that is a factor that is given the most weight. Now, of course, that means not only the price made to the Government by you, but also after recapture of excessive profits what would be the final net cost to the Government of the item manufactured by you.

Now here is a case where a high margin of profit on 1942 sales is left with the contractor. A firm that has produced a bombsight—the ones you have heard of a great deal and have meant so much to us in the winning of the war—for a period of 3 years previous to the war, took a very heavy loss on that development. When we came to re-negotiate that company, we allowed them all the losses for the 3 years and threw it all in on the profit they made in 1942. As a result that company got a very high margin left to them after re-negotiation of 1942, and they really earned it. Now, you can't catch a thing like that by taking a flat formula of a certain percent of, say, 4 percent, or 6 percent, or anything of that kind. It will never take care of a man like that, a manufacturer who has done an outstanding job to win the war.

Then we have another factor to take into consideration, and that is the difficulty of conversion from your peacetime operation to your war operation. In other words, if your cost of materials run 80 percent of your total costs, then you are not very highly

integrated in plastics. But if your cost of materials runs 20 or 30 percent and includes the items subcontracted, then you are more highly integrated and that is taken into consideration.

Now I want to talk about risks. We do take risks into consideration. We take into consideration the risks you have in connection with the change in labor and material costs, and also product hazards—explosions. I am thinking of one of the powder manufacturing firms. We completed a re-negotiation of this firm. This firm was carrying all the explosive risks on these plants because no insurance company would write them. They had one explosion a couple of years back that cost them a lot of money, and now they have a number of additional plants, and they are doing a splendid job on production of powder. We took into consideration this explosion risk, and we allowed them that additional cost item.

We have material shortages. Companies spring up in the war effort, and after the war is over they don't have any regular civilian business to go back to. They are, therefore, taking greater risks, and they're taken into consideration. Some of the risks you have are on inventory losses and in connection with contract terminations, particularly if you are down in the fourth or fifth years of the contract.

Then we take into consideration the amount of money you invested—the amount of money you put into your business to turn out war production. Let us say that you had a million dollars invested and you put in another million at your own risk. Naturally we allow you more than if you had the D.P.C. build a plant for you and turn it over to you, because that would be a million dollars of the Government's money.

Last of all, the N.A.M. made a survey in connection with war production. They questioned a large group of people throughout the country in order to hit the law of averages, whether or not they thought excessive profits were being made by industry on war production, and learned that approximately 30 percent of those voting said they were quite certain that excessive profits were being made on war production. Along in December N.A.M. made another survey and this survey resulted in the public saying—I mean over 70 percent of those voting—that excessive profits were being made out of war production. In winding up the summary on this survey the N.A.M. said a public indictment of industry for profiteering may serve to tip the scales against retention of free enterprise system after the war. In other words, the N.A.M. is interested as we are in seeing to it that industry comes out of this war clean and strong, with the marvelous record which they have already made on producing what nobody thought was possible 2 years ago.

C. C. LIVINGSTON

Now, we need the cooperation of industry for industry's own sake. We have to get the facts. We work on a sort of a 4-way plan. We first get the facts because the man's judgment is not better than his information, and then we use the facts as a basis for planning what is a fair profit. Then, naturally, we on our side prepare to sell you on our ideas as to what is a fair profit. You on the other side of the re-negotiations table, if you prepare your case properly and I am recommending that you do it, get all the facts on your performance, risk, and so forth and, when you come in, try to sell the re-negotiationers what you think is a fair profit and what you think is excessive.

Finally we have what we call the follow-up where we are both anxious to get the job completed—to get the amount established—to get a just price—to get an adjusted price—and to get the cost of this war reduced and still leave a just and fair profit to industry. Now, as I said, the cooperation has been splendid from this industry, and when your executives asked me to come and talk to you today, I was most happy to do so, for no other reason but to tell you that we do appreciate what you are doing in cooperating with us—in getting this job done and determining what are excessive profits in getting the cost of war production lowered, and in doing your part in winning this war.

We have a big job to do. As I said there are over 20 thousand contractors, and in the War Dept. alone over 1 hundred billion dollars appropriations already affected in the way of purchasing contracts.

We want to emphasize again that with your cooperation we will at all times attempt to give each one of you a fair and just profit on war production and to take up as little as possible of your time in filling out any forms, or anything of that kind to get the job done, so we can all spend as much of the time as we can on the big number one job, and that is to lick Hitler and the Japanese as quickly as possible.

Mr. Livingston then introduced the next speaker, Professor R. W. Stone, professor of Industrial Relations, University of Chicago, and member of the executive committee of the Industrial Relations Association of Chicago. There follows a résumé of Professor Stone's address which concerns *Current Developments on the Labor Front:*

For the past 10 years, this Nation has been suffering from a series of situations. We have been through one emergency after another. Unemployment compensation beginning 10 years ago was a widespread phenomenon. Everything was in jeopardy. Businessmen as well as workers had lost confidence in themselves, and they both went down to Washington for help. The War is only a continuation of this trend. Thousands of agencies are engaged in a process of working out a new program. Now, among them rises the question of the labor front, that is, the position that organized labor will and should have in the world immediately ahead and in the period beyond. In examining the meaning and implication of the things that are developed and are in process on this organized labor front, I think it is necessary that we first get before us certain essential facts about developments up to the present time.

It is probably known to most of you that union membership is now between 12 and 14 million, probably nearer to 14 million. That is an increase of 400 percent in the last 10 years. The major part of that growth has occurred in manufacturing. Ten years ago not over 2 or 3 percent of the workers in manufacturing were members of unions. Now over two-thirds belong. Moreover, the unions have had time to get themselves firmly established, and this entrenchment has been enhanced by the fact that Government has ordered maintenance of membership rules in a great many corporations.

Along with this change in size, the nature of unions has changed, and the nature of their processes or functions has changed. These are some of the respects in which the changes have occurred. Collective bargaining as such has practically disappeared. By collective bargaining I mean the determination of terms and conditions of work through direct negotiation, and agreement through mutual understanding between workers and employers or groups of employers. Unions are not now primarily collective bargaining agencies. Wartime controls over labor relations have only enhanced this process. It was well under way before. The elaboration and expansion of the work of the National Mediation Service is one way in which the Government had taken collective bargaining in hand.

Now, the traditional American Federation of Labor philosophy, the one that was written into the Wagner Act, held that unions were an agency to mitigate, in effect, the competitive processes but not to supplant them. Unions were a part of the free enterprise system. Their purpose was only that of effecting influence and amending the operation of competitive processes, not the supplanting of competitive processes in determining conditions of work. In those days unions had no political aims.

Now, there is another point I would like to make about the total union situation as I see it. I just recited a few facts about the phenomenal growth in unionism. It is my judgment, however, that the union movement has probably reached a peak of expansion. Surely, they will go on and win some additional elections here, there, and elsewhere, but they are in a position of the

axis powers, concerned essentially with a defensive line of action. It should be noted that organized labor represents less than 1/4 of the total work force, and I think you will be leveling off at this point.

The reasons for this fall along the following lines. First, a large part of the new union membership was coerced or rushed into unions. Perhaps more rushed than coerced, but a combination of both. A great many of these new union members are not good union members. To them it is not a cause. It is something that happened along with all the rest of the things that happened in the course of the past 10 years.

A great many of these people because of shifts in work from one plant to another, will, despite the maintenance of membership clauses, drop out of unions. By and large, I suspect not over 40 percent of union members are actively interested in unions. When I say that, I am not saying anything that is not true of practically every other institution. Not over 40 percent of the population of the United States is sufficiently interested in Government to go to the trouble to get out and vote under any ordinary circumstance.

The second reason is that unions, under present circumstances, can do relatively little for their members. This I would say despite the fact that according to the papers, Senator Byrnes has given the War Labor Board somewhat additional controls over industrial wages.

Now I think the third factor that is limiting the expansion of unions and bringing the movement to something of a halt is the fact that a great international union covering the whole nation can serve workers only in a limited way. A big international union can deal only with issues national in scope. They can have relatively little influence over the matters of day to day human relationships in a plant.

Another reason that is bringing a limitation on union growth is a public opinion that is becoming more and more hostile—critical would be a better term than hostile. Some of the States are passing regulatory acts. Even the Federal Government has made a mild beginning in that direction. And the union movement has run head on into another big pressure group movement, the farm bloc.

Finally, I would suggest that unions have been oversold. Workers have expected more from unions than they had any reason to expect.

I don't mean to indicate that I think the union movement will fall to pieces. All I have suggested is that these are evidences that we are coming to the crest of a wave of rapid union expansion.

However, unions are here to stay. I think it would be a false hope to assume that they will of their own accord fall apart, and I think it would be wrong on the part of business to assume that by force they can destroy unions. I don't think it will be permitted.


R. W. STONE

There's a fundamentally sound argument for trade unionism and collective bargaining. Wherever workers are employed as members of groups, working together as members of a group, they should as a matter of procedure deal collectively with managers. It is unrealistic to assume that under conditions of group work, workers will or should act as individuals with no group relations.

The only question that seems to be open for discussion is: what kind of working organization and what kind of collective bargaining will be constructive, will harmonize with and advance public interest? I don't think public opinion will support a ruthless anti-union drive on the part of either Government or management. Public opinion will, however, welcome and support a program that preserves the virtues of the institution, but strips it of its harmful and anti-social elements.

So we come to the question of what are the elements of a sound program with respect to organized labor. Management needs to have such a program; Government needs a new program with respect to organized labor and the unions themselves, the union leaders, need also to take stock of what has happened, as to what they are going to do, what they would like to do, could do, and should do with these unions if they want to have them given fair and proper consideration in the future.

Now, I haven't time to more than scratch the surface, but with respect to management I can summarize in just a few words. A manager can do himself most good in thinking through his industrial relations problems and in acquiring a sane, constructive and proper attitude toward unions, if he will work out a program that he would use if he were a union official organizing his plant.

Or, another way to put the same thing is to think of all the different reasons why workers usually join unions. Then proceed, as a manager, constructively to meet the different reasons for workers' joining unions. The reasons workers join unions can be summarized under several different headings. There are different ways of approach, but workers join unions for other reasons than higher wages.


V. FABIAN

One reason we have this enormous union movement is that workers were thoroughly frightened. They had lost their jobs. Everybody's job was in jeopardy, and they were hunting for something that promised security. Quite irrespective of the ability of a union to give security, they still joined them for that reason among others.

Some workers join unions to get the kind of personal response they miss in their working relationships. They join unions in order to get recognition, and meet what they consider abitrary treatment on the part of management. They join unions, by and large, to get increases in wages, and security. Then sometimes they join unions just for the sake of novelty, a way of raising hell and getting new experiences. These things have value under controlling circumstances and considerations.

Unions do tend to act monopolistically. There isn't any industry in which unions have been established, had collective bargaining relationships over a period of as much as 20 years, in which they have not substantially reduced employment. They do that because they inevitably tend to raise wages too high and to impose restrictions that raise costs. Generalize that, and if we had all workers organized we would tend to produce an economic system in which we could not possibly hope to provide full employment for the major part of the population.

Now, the one thing that is transcendent in Government policy is that unions should be restrained from those actions which mitigate against full employment, the full employment possibility. Unions are, in fact, organized primarily against other workers rather than against employers. Most labor problems rise out of the fear of unemployment, so we get nowhere from a program that is conducive to restricting rather than enhancing employment.

Now, the major part of any program of action, it seems to me, will have to be a constructive program by businessmen themselves. If business wants in the postwar world to retain its leadership, to be accepted as a leader in the free society we hope to attain, then it must assume the responsibility. It will not assume that responsibility by a completely negative attitude.

At the conclusion of Professor Stone's talk, Mr. Livingston introduced an unscheduled speaker, Victor Fabian, Asst. Regional Director of Smaller War Plants Corp., WPB. Mr. Fabian spoke on the activities of the Smaller War Plants Corp., particularizing on conditions in his territory. Excerpts follow:

To many of you, the Smaller War Plants Corp. is just a name. You wonder what it can do for you and how you can use it. The problems of war production made it necessary to organize separate staffs to assist the various procurement agencies in war production. The earliest organization was that under Gen. Knudsen, started in Chicago, March 18, 1941. This was known first as the

Contract Distribution Branch. The latest development is that of production services.

Prime contractors in war production did not have all the facilities for producing ammunition and guns. Such machines as they did not have within their own plants, they naturally tried to procure from other industries. That led to subcontracting. As subcontracting got larger and larger, the manufacturers who did not have facilities for war production became more and more wrought up over the matter. Their personnel was gone, their machines were lying idle, their capital was dwindling daily since they had to keep on a small proportion of their workmen and they had no work with which to supply them. They became so vocal that the Congress finally was persuaded to take some action. Last summer Public Law No. 603 was passed establishing the Smaller War Plants Corp. and outlining somewhat sketchily what they should do. The primary objective was to utilize in every way possible the facilities, the personnel and intelligence of the so-called smaller war plants in production of war implements.


E. E. MILLS

How could we do it? The first step in qualifying for any Government production work is to make known your facilities to the WPB. In other words, when you come to our office, we ask you to supply us with what we call a 1546 form, which is a list of your facilities, your management, your capital, the size of your plant, etc. With that before us, our staff, which is composed entirely of production engineers, analyzes those facilities and tries to fit them in some way into the production picture. Under the Smaller War Plants Act, this procedure was changed somewhat. We were told that these manufacturers would become prime contractors instead of subcontractors.

How are they going to do it? The Smaller War Plants Corp. in Washington goes to the procurement agencies and says: "You have 10 million tents that you want produced. We have a lot of distressed textile people, textile processors, who can produce a small quantity of those tents. Now, instead of giving that tent job to your usual line of prime contractors, let us have $2^1/_2$ million of those tents to spread around over the United States to these small fellows who can produce them. They can produce them in the same length of time as the prime contractors would. Maybe they will cost you a little more, but the Congress has appropriated money for that differentiation in price. We have to keep our economy intact and we have to keep these little fellows in business because you are going to need them when the war is over." That's the way it works. It doesn't work to your disadvantage. It simply spreads the work to the little fellow who needs it.

How are you going to get the benefits of the Smaller War Plants Corp. if you happen to be one of the small distressed plants? You contact the Smaller War Plants office, which is usually located in the same office with the WPB, and ask them to make a plant inspection. They will go out and make that plant inspection, find out what tools you have to work with, what your degree of distress is, and certify you as a distressed manufacturer.

What makes you a distressed manufacturer? In the interpretation of the Act, Gen. Johnson said that any manufacturer who at present is doing less than 66 percent of the business that he did in the 5 years previous to 1941 is a distressed manufacturer and is entitled to relief under this Act. That, however, is being interpreted liberally.

Any questions? Would you like to know how you can make use of Smaller War Plants? Do any of you need subcontractors? We have in the Chicago files the plant facilities of over 11,000 manufacturers in Indiana, Illinois, Wisconsin and Iowa. That includes practically everyone who has something that will turn and produce for war. Whatever kind of gadget you want, the chances are we can find it for you. Your industry is very fortunate. In the year and one-half I have been with the WPB, I can't recall more than two instances where I had to go to bat for the plastics industry. In an industry like this which I am told is working 3 shifts a day around the clock, 7 days a week, perhaps you can help in this effort and assist these other manufacturers by giving them some of your work.

Following the afternoon general session, 4 sectional meetings were held. The Molders division, called to order by W. B. Ross of Diemolding Corp., was first addressed by Floyd McCullough of WPB who described in detail the Controlled Materials Plan and how it is intended to work in collaboration with the more familiar priority system. Present in the audience were Grayson Wilcox and Clinton Rector, both of the Plastics Division, Chemicals Section, WPB, who assisted in the lengthy and complete question and answer period following Mr. McCullough's talk.

William Cruse, executive vice-president of S.P.I., made an informal report for both the Thermoplastic Materials Committee and the Thermosetting Materials Committee. Because of the official administrative standing of these committees, Mr. Cruse explained, no actual report or meeting of the committees can be held outside of Washington unless ordered and attended by the Divisional Chief. However, all molders present were invited to make known their thoughts and comments for the benefit of those committee members who were present. The information so gained thus can be passed on to the full committee at the next regularly appointed meeting in Washington.

The Machinery, Tool and Die Division met under the direction of Frederick G. Schranz, division vice-president of Baldwin Southwark Div., Baldwin Locomotive Works. Mr. Schranz introduced F. A. Lawlor, of Ziv Steel & Wire Co., who delivered a very instructive talk on steel. Next Mr. Van Deaman, of Holliday Steel Co., spoke on *Speed Treatment and Speed Case of Hob Steels*.

The Canadian Section met separately with A. E. Byrne presiding and delivering a report of its activities. The complete text of this report will be found in the summary of the Friday morning session of the Conference.

At the extruders' divisional meeting, Elmer Szantay, of Sandee Mfg. Co., was elected chairman for the year; Dr. R. P. Allen, of National Rubber Machinery Co., vice-chairman; and John Wetherby, permanent secretary. Mr. Wetherby described to the Extruders' group the *Manual of Extruded Shapes* which S.P.I. produced at the request of the Naval Aircraft Factory. It was decided to bring out a revised edition including much more information on extrusion formulae, shapes and other available data.


H. SPENCER

Also it was proposed to undertake surveys on wage rates, sales volume and available extrusion equipment so that the participating members might obtain a picture of what other extruders throughout the country are doing and compare their own position in the industry. James R. Turnbull of WPB, speaking from the floor, advised extruders to prepare for a possible allocation of cellulose plastics and to determine the specific end uses of extruded products in order to be sure of obtaining material.

The entire Conference reconvened in the evening to attend a dinner meeting at which Elmer E. Mills presided. Mr. Mills introduced the 28 members of the Chicago committee who helped

prepare for the Conference. Herbert Spencer, Durez Plastics & Chemicals, Inc., announced the formation of the Plastic Pioneers, a group of "old-timers," or individual members of S.P.I. who have been in the plastics industry 15 years or more ("equal to 50 years in any other occupation," Mr. Spencer opined). "The Pioneers are an honorary group," Mr. Spencer continued, "men your officers and directors feel have contributed much to the progress of our industry through the years. They are men who recall the many and varied efforts to develop an organized industry, and who remember the days when they looked for jobs that met material limitations rather than materials that met the job. They are men who remember many little everyday annoyances that were headaches but that go to make up an understanding, a respect and a liking for those referred to as 'damned' competitors. Yes, competitors and free enterprise have made America, have made the plastics industry—and such are the Plastics Pioneers—may their number never grow less."

Guest speaker at this dinner meeting was Brig. Gen. K. E. Rockey, U.S.M.C. General Rockey in a stimulating timely address reviewed the history of the Marine Corps and their rôle in the present conflict. He acknowledged the contributions that plastics have made to the war effort and urged the plastics industry "to conceive, design, and produce plastics to supply a war need; to achieve a saving in time, cost and weight, and to relieve the strain on the critical materials."

SPI

Friday morning's session convened under the chairmanship of James E. Johnston. The first speaker was Morris Ullman, Parts and Subassemblies Unit, Machinery Branch, OPA, who spoke of the fundamental questions involved in the relationships of the molders and fabricators in dealing with the Office of Price Administration.

Passing over the pricing of plastics raw materials and consumers' goods, for which provisions and procedures are fairly clear, Mr. Ullman concentrated on the subject of the special molded and fabricated parts which comprise the major part of production in the plastics field. MPR 136, he said entitled "Machines and Parts and Machinery Services," covers most of these plastics parts and subassemblies. This order differentiates between list price and non-list price items in that prices of the former are frozen as of the base date (March 31, 1942), while only the method by which prices are arrived at is frozen for the latter.

J. E. JOHNSTON

Molders and laminators producing non-list price items are required to apply to their price estimates rates for labor, overhead, machinery hour rates, spoilage, gross margin, net profit, etc., no higher than those which entered into such estimates on the base date. Any molder, however, who has estimated his price on a new item and made the first run, can recompute the maximum price on the basis of actual production experience. If his costs run higher than his estimate, he can quote a higher maximum price if he first notifies OPA. If his costs run lower, it is mandatory that he sell at a lower price. This method of price recomputation enables the plastics man to determine his costs on the basis of actual experience and regulate his prices accordingly.

MPR 136 permits any molder to apply for a list price on his product if he presents evidence that the price has been computed in accordance with the frozen price determining method used on March 31, 1942. Disadvantage of list prices is that the manufacturer must absorb all the additional costs which may arise as a result of subcontracting part of his work.

The molder who is producing items subject to the recomputation provisions of MPR 136 can adjust his maximum price to reflect the actual cost of subcontracting if his subcontractor's price to him is established in compliance with the order, and if he knows in advance that he will have to subcontract part of his work. If he is forced to subcontract after he has computed his price, he must re-negotiate his contract with the procurement agency involved.

Order 229 recently sent out to the industry, Mr. Ullman explained, applies the same type of pricing procedure contained in MRP 136 to parts in assemblies not covered by that order and not in the exempt group of plastic products. In other words, the new order functions in the miscellaneous plastics parts field. This order asks that the molder file information telling how he arrived at his maximum price.

The speaker next undertook to dispel some current misapprehensions about what constitute exempt plastic products. He explained that, although certain combat items and their parts are exempt from the provisions of the General Maximum Price Regulation, many plastic parts going into them are covered by other regulations such as MPR 136. Where the status of a particular part is in doubt, the molder should consult the nearest OPA office or the national office.

M. ULLMAN

In conclusion, Mr. Ullman suggested that each molder and laminator keep at hand copies of important OPA price regulations affecting his business, including the following:

- MPR 136, covering the industrial plastics parts.
- Order 229, covering the miscellaneous plastics parts.
- Revised Supplementary Regulation No. 1, listing the exempt products.
- MPR 188, covering completed consumers' goods.
- Amendment 71 to 136, pricing in new or converted plants.
- Amendment 78 to 136, the procedure in applying for price adjustments.

The next speaker was J. D. Lincoln, Virginia-Lincoln Furniture Co., Aircraft Div., whose organization has been responsible for developing many unique aircraft parts molded at low pressure, and for some remarkable achievements in low pressure molding. A digest of Mr. Lincoln's speech follows:

We have had an interesting experience with low pressure laminated molding or, I should say, with reinforced plastics. Thirty years ago we used concrete, but in the last few years we have turned to reinforced concrete. Now, we are using reinforced plastics.

In resins, out of perhaps 100 resins that are good, it is a question of the one which can be obtained today that counts. We stayed in the urea field for a long time because they were available; they weren't strategic at that time. I know that some of the materials are critical. We have used a lot of fiberglas. This is going to be a little tough to get although I understand that by the end of the year there will be plenty. If by the end of the year there is no war, then we may be able to use it to build refrigerators.

The way we laminate and mold is easy. If it weren't, we couldn't do it. We have had a few things that were hard, and those are the ones we haven't done as yet. We are still working on them. But I am pretty sure we will lick these problems because we are stubborn. The hillbillies down in Virginia where I live don't know how to take "no" for an answer. I tell them to go and try it. We hire engineers to come in from other aircraft plants. We have had some who did a good job on drafting. But when it comes to building, you need workers who don't know it won't work. As I say, we still have projects that won't work out even when we switch resins 4 or 5 times.

I am sure that there is a big field in aircraft parts but comparatively we haven't done very much. Today we have about 40 or 50 parts being made and on test which some day will represent business. Here you are not substituting for aluminum. You are

trying to make something which is better and cheaper than aluminum. When you get aluminum that must be drop-hammered and then flash-welded, you are shooting toward high-priced product fabrication.

We were in the furniture business. Later we went into the molded plywood business and now we work with other reinforcing agents, glass and cotton, muslin, P18 cloth and boot cloth. We have tried paper. I expect some of you have tried paper with experiences similar to ours. It looked bad a year ago. We made a gas tank section out of paper. For about 3 months it held the gas very well but it didn't stand weather for a longer period. In other words, the paper delaminated within itself. However, I am sure that paper now can be laminated by a new vacuum process of sucking resin through the paper while it is being made. If we could take some of the lignin out of the paper and replace it with a better resin (possibly casein), I am sure it will make a real product. After we do that, I believe we can get almost as much strength with paper as we do with fiberglas.

J. D. LINCOLN

I have two little samples here. One of them I made by low pressure laminating. The other was made by someone else and is a good-looking piece. Its surface has a bright gloss, whereas that of the low-pressure piece is dull. I call high pressure laminating, 300 lb., because that is high pressure to us. Some of you even go to 3000 lb., but none of our tools hold up at over 100 pounds. The paper was laminated at 60 p.s.i. I think the tensile strength on the high pressure piece is 23,400 p.s.i., while the tensile point on the lower pressure piece is 19,300. When you take the difference in the specific gravities of the two pieces, the specific strength of the lower pressure piece is greater.

Now, I am not saying that there will be no more high pressure laminating. When you have a small part, you had better put all the pressure you can on it. Where big structures are involved, tool costs immediately become excessive. Low pressure laminating then is advisable with a pressure of from 25 to 75 pounds. Below that there is a new field of "no-pressure" laminating. A lot of you are working with that and have done a good job on it. With this "no pressure" laminating, I am sure a lot of us are going back to the old-fashioned vacuum bag method used extensively in the furniture business back in 1934 and 1935.

As I say, fiberglas for reinforcing has been a main item with us. Now we must turn to other reinforcing agents because this month our requirements alone, if they could be filled, would consume about 110 percent of all the fiberglas that is made. On the fiberglas we have obtained, but not in our own test laboratory, the highest tensile strength is of 83,000 p.s.i. That is a good high figure, but it won't do us much good. I know of but few instances where we could use the full value of 83,000 lb. unless it were in a strap around a tank, a strap around a fitting on an aircraft part or in some part that doesn't need any compression strength.

G. M. KUETTEL

As long as the war continues, I know that everyone here is interested in building war products, and I am sure everyone can get all the business he wants. But I believe that plastics will just start when the war is over. With the demand for large structures, such as refrigerators, stoves, houses, and air conditioning units, low pressure laminating will come into its own.

I might say laminating is good for quantities of from 1000 to 5000. If real quantities are needed and you can make a high pressure tool for it, don't fool with low pressure laminating. You will beat it all to pieces with high pressure methods. Low pressure is not cheap. With the big structures, high pressure sock-them-out methods are, I would say, 40 times as fast as ours.

I believe you will find many more big structures being made from plastic material than in the past. The biggest structure we have attempted thus far is a sphere 34 ft. in diameter, with the bottom cut off. It's only 26 ft. high and is made entirely of plastics. When the war is over, it is going to be interesting to hear about all that has been done. I know a lot of you have material at the front that is really doing great work toward winning this war, and the first meeting of this Society after the war is over is going to be intensely interesting.

The third speaker on the program was Dr. G. M. Kuettel, E. I. du Pont de Nemours & Co., Inc., who discussed a recently developed material, higher-resistant Lucite. Since this speech is of extreme importance and of great technical interest, the article along with additional illustrations is reprinted in full in the Technical Section of this issue (see page 98).

R. F. Boyer, Dow Chemical Co., the next speaker, was scheduled to talk on Styraloy. Because of governmental restrictions he found it necessary to change his topic to *Polymerization and Copolymerization*. His talk was of a highly technical nature, outlining the history and development of polymerization and copolymerization, and he illustrated it by graphically demonstrating the building up of molecular chains, showing how composition of materials are altered by varying chain lengths, adding plasticizers, etc. Mr. Boyer compared copolymers with metal alloys indicating that the same type of surprising results obtained by blending various metals may also be expected by mixing various copolymers to obtain new "tailored plastic molecules which will have almost any desired properties."

R. F. BOYER

Mr. Boyer reviewed what has already been accomplished in the field of copolymerization in the present transitional stage, describing various materials such as vinyl chloride, polyvinyl alcohol products, synthetic rubbers, etc., and pointed out that variations of basic ingredients in order to get specific characteristics may result in the future in a bewildering variety of copolymer plastics.

In the absence of Frank Warner, of General Electric Co., chairman of the S.P.I. Technical Committee, William T. Cruse gave the following report covering some of the committee's activities:

1. *Classification system for plastics.* While not unanimously approved by all participating organizations, it is being used by the Tariff Commission, Bureau of the Census, Bureau of Foreign and Domestic Commerce and other agencies as a basis for the preparation of a recommended form for statistics on types of materials covered by the system.

2. *Plastics button specifications.* Representatives of the Button Division met with officials from the Quartermaster Corps when the proposed draft of specifications was reviewed. The Army now is using plastics buttons almost exclusively and their procurement is governed by these specifications.

3. *Plastics industry Optics Committee.* The Naval Observatory with the cooperation of the committee, last year obtained an appropriate plastic, an alternate for rubber, to be used to cover binocular bodies. These plastic covered binoculars now are being purchased in volume.

At the first meeting of the Optics Committee at the Naval Observatory, Washington, the possibility of molding complete binocular bodies was considered. It was recommended that experiments be undertaken to determine if any existing plastic materials would be appropriate for the purpose. Fortunately there was in existence a binocular body mold and a number of samples of phenolic materials were molded. Accelerated tests were run on these molded experimental bodies. Because of the encouraging results obtained, the Naval Observatory now is arranging for the construction of molds for producing a quantity of binoculars.

4. *Resin adhesives Technical Committee Subdivision.* The Resin Adhesives Division assembled and published material for what is in effect a shop practice manual for the use of various types of adhesives in assembly gluing.

5. *Thermoplastic Division.* At the request of the Naval Aircraft Factory, the Thermoplastic Technical Subdivision undertook in collaboration with all extruders in the industry the preparation of a book to include a list of all of the manufacturers of this class of plastic products, as well as a description of the various sizes of tubing and profile shapes available. Under Dr. Kuettel, the committee assembled material which it published in the "Extruded Plastic Tubing & Shapes" manual.

6. *Naval Aircraft Factory.* It called upon S.P.I. to collaborate in arranging a conference for the purpose of considering stressed applications of plastics in military aircraft. The meeting was held at the Warwick Hotel, Philadelphia, on February 9 and 10. Representatives from all of the major aircraft companies and from the principal material manufacturing companies were present.

G. CLARK

7. *War Committee on Radio.* The War Committee on Radio, presided over by S. K. Wolfe, chairman, Chief Components Section of the Radio and Radar Branch of the War Production Board, was asked by the Signal Corps to assist in the preparation of specifications for and on plastics as used by the Signal Corps. The Subcommittee on Insulating Material Specifications for the Military Services, under the chairmanship of Dr. Alfred N. Goldsmith, called upon S.P.I. to assist by providing personnel from its membership. These specifications are now nearing completion. Three subcommittees, established to undertake the work—Thermosetting, Thermoplastic and Laminates—have accomplished their objective.

8. *The Chemical Warfare Service.* At its request, this agency was supplied with samples of thermosetting laminated materials for certain tests being conducted to determine the stability of this class of materials when exposed to lewisite and mustard gas.

9. *The Quartermaster Corps.* The QMC requested that S.P.I. arrange to have material manufacturers supply them with molded samples of various types of materials for color stability tests, and this request was transmitted to the suppliers.

Following this committee report, George Clark, Formica Insulation Co., spoke of the work of the S.P.I. Subcommittee on Laminates. A summary is given below:

The original purpose of this committee was to form a contact point between the Army and Navy and the plastics industry. The Army Civil Aeronautics Committee, composed of members from the armed services and several other bureaus of the Government, needed some contact with the plastics industry, and the Plastics Industry Committee on Laminates is the result. The personnel of the committee is drawn from S.P.I. and from the Laminated Section of N.E.M.A. There are 26 laminators receiving allocations of resin from the WPB at present.

The duties of the committee, as I can see them, are to provide the aircraft manufacturers with design data on plastics—in this case, on laminated plastics. Eventually an ANC Handbook will be brought out, covering all the standard plastic materials and such other special materials as are required for the problem at hand.

The ANC Committee set up theoretical specifications for the physical properties of laminated products that can be applied in three categories, namely, the non-structural, semi-structural and structural. Samples of industry products, shipped to Naval Aircraft Factory and Wright Field, were tested against these specifications to find if any products currently available could be used on aircraft.

In furnishing samples, all of the standard products of the industry were involved together with such new products as were available from urea materials, Plaskon materials and new Laminac resins, also CR 39. These were combined with such new reinforcement materials as fiberglas.

Next, the ANC Committee asked us to furnish a résumé of the possibilities of extending phenol or cresol resins. We canvassed the entire industry and made a detailed report on all the possibilities for extending the materials now in use. It appears to me that there will be enough materials of the kinds we need to supply all the laminators.

The high point in the affairs of this committee was the Industry Conference. This meeting was divided into three groups, and it so happened that the laminators had the very largest. Of greatest interest, in my opinion, was the report by the Naval Aircraft Factory and by Wright Field on the tests that had been made on the standard products of the laminated industry and on the special products. A real job was done in testing those materials, and 3 or 4 hours were devoted to reporting the results. Afterward the aircraft manufacturers were given an opportunity to criticize and explain the data, and ask questions about the tests. Finally, the laminators had their say, particularly as to new materials in process of development. Mr. Slater, of Owens-Corning, discussed fiberglas; Mr. Glidden, of the Hood Rubber Co., talked about his company's experiences in low pressure molding. Perry Wilson spoke on the handling of the low-pressure molding phenolics; Mr. Foote, of the WPB Chemical Section, outlined their position on resins; Mr. Melamphy, from American Cyanamid's Plastics Div., talked about Laminac resin; and Mr. Barber, of St. Regis Paper Co., discussed high-pressure molding.

One fact brought out by this meeting was that the aircraft industry still is without complete information on laminated plastics and without specifications that apply strictly in their field. This lack has made the new ANC Handbook more important than ever, and every effort is being made to get it published as quickly as possible.

Since both Wright Field and the Naval Aircraft Factory were unable to do all the testing work required, they came back to the industry for data on its own materials and the industry found itself in the position of not having enough equipment. Your committee has found the solution to this problem. The members of NMAC were able to furnish funds for the establishment of a testing agency. After some investigation, the Engineering School of Johns Hopkins was selected as having sufficient equipment for carrying on the work. The laminated industry has provided funds to bring the school to a point where it can make all of the standard tests in the Naval Aircraft Factory.

A. E. BYRNE

The final speaker at the morning session was A. E. Byrne, pinch-hitting for J. L. Dean, Chairman of the S.P.I. Canadian section, who gave a brief history of the formation of S.P.I. in Canada and the work of the Technical Committee.

"I think it was Shakespeare who said it was an ill wind that bloweth no good," said Mr. Byrne. "It was the ill wind of the phenolic resin shortage that organized the plastics industry in Canada. That was about 2 years ago. A meeting was called with our chemical comptroller, a counterpart to your material comptrollers, and an advisory committee was organized which continues to advise us on material supply. At our convention last January we organized S.P.I.

Mr. Byrne mentioned that the Technical Committee was organized at the April 21 meeting (a list of committee members appears on page 116). The purpose of the committee, he continued, is to get full recognition from the Canadian Government, and it appears that the S.P.I. Technical Committee will be the authoritative committee on plastics,.

Mr. Byrne described the committee as closely tied with this country and with the British Technical Advisory committee where many Canadian specifications originate. (*Please turn to next page*)

At the Luncheon session, over which Ronald Kinnear, presided, the annual election of officers were held, as described on the first page of this report. William T. Cruse, then presented the Secretary-Treasurer's report, including slides showing charts and graphs prepared by the Society's statistical department.

Elmer C. Maywald presided at the Friday afternoon session. The first speaker was Clinton Rector, Chief of the Thermosetting Unit, Plastics Section, Chemicals Division of WPB, who discussed *Plastics and Allocation*.

Mr. Rector stated that today, in order to maintain the mass production of war implements, it has been necessary to use plastics to a point where the capacity of the industry is being challenged. The war has brought about a violent change in the relative demand for various products, he continued, increasing the demand for those materials having unusually rugged or utilitarian properties. The priority system, worked out to establish the proper allocation, proved to have two weaknesses. The first was the relatively uncontrolled distribution of rating with no means of determining the supply available while the second weakness was the extreme uncertainty of the supply of raw material. Modifications have been made until the system works as follows:

C. RECTOR

Facts surrounding the commodity are ascertained, Mr. Rector said. The capacity of the industry to produce the allocated commodity is estimated, the available supplies of raw material and any alternative materials that can be employed.

Next it is necessary to decide whether the device to be made is essential to the war effort. If the answer is in the affirmative there are the secondary questions to be ascertained.

1. Is there a suitable substitute that is more available?
2. Will this interfere with some more essential demand?
3. Will this production require materials or chemicals more needed for some non-plastic usage?

In all these determinations the yardstick is that all-important factor, the end use, Mr. Rector pointed out. Under chemicals and plastics orders, end uses must be accurately defined.

Another problem Mr. Rector described as confronting allocators is that of coordinating the requirements for key raw materials with all contingent demands for such materials. In addition the administrator of an allocation order must accumulate all available facts concerning future demands and availability and confer with other divisions with a view toward arranging the necessary collateral requirements for production and distribution.

Mr. Rector proceeded to give a summary of the history of plastic allocation orders. A condensation of this material follows:

Back in 1941 the vinyl chloride polymers and copolymers already had started to carry a man-sized load in the war production or defense program of that era. These were the first of the plastics and synthetic resins to be placed under allocation control. The only important revision to the order was the addition of the vinyl acetate polymers, including polyvinyl butyral, polyvinyl formal and polyvinyl alcohol. The key raw material for most of these resins is monomeric vinyl acetate, and this commodity immediately reflected the great load of military demand on the end product resins. Accordingly, another allocation order, M-240, was issued under which monomeric vinyl acetate is allocated to the resin producers, automatically giving the Chemicals Division a certain measure of control.

Similary, during the fall of 1942 the demand for phenolic plastics had grown to the point where the total availability was far short of the amount demanded, and many important usages were not being covered while a variety of unimportant items were being produced. Order M-246 was, therefore, issued in November to provide a means of channelling the available phenolic plastics into those usages which were most important to the war effort.

The allocated plastics and synthetic resins now include the following materials listed in the sequence in which they were placed under allocation control: vinyl chloride polymers and copolymers; ethyl cellulose was placed under allocation on June 18, 1942; soluble nitrocellulose on August 6, 1942; acrylic monomers and resins on December 10, 1942; polystyrene on April 5, 1943; vulcanized fibre on April 22, 1943; and casein on April 4, 1943.

Maj. E. L. HOBSON

In addition to these orders which cover the distribution of the plastics themselves, it has been estimated that there are 50 allocation orders which have become necessary to maintain a balanced supply of the various chemicals from which the plastics are built. There are under construction at present a number of plants for the making of raw materials required for the manufacture of plastics. With these new facilities, the outlook for the future can be summed up as follows:

Ethyl cellulose has been short for a considerable period, and its present situation is one of the tightest in the thermoplastics field, with some important military uses going unfilled. Increased production during the fourth quarter should relieve this situation as far as military requirements are concerned.

Cellulose acetate molding materials have undergone a considerable change in the last 60 days. We are in the tightest squeeze on this material since the beginning of the war, caused by a steady increase in military uses for cellulose plastics, and a decline in the production rate caused by a shortage of raw materials including plasticizers. The same situation prevails in cellulose acetate butyrate molding materials.

Clear cellulose sheet plastics of all types and gages are short.

Nitrocellulose plastics are currently the only raw material in the cellulose group for which the present picture is extremely favorable. Reduced military demands have relieved linters and nitric acid, and these raw materials are complemented by a good supply of camphor for plasticizer.

Acrylates and methacrylates are slowly building to a level where all military requirements will be met for both cast sheet and molding material, although certain special polymers and copolymers for nonplastic uses will continue in an unfavorable situation. The expectation is that the third quarter of this year should see us well out of the woods on these materials as a result of the completion of plant expansions started in 1942.

Polystyrene is limited only by the availability of styrene monomer, but as far as any civilian uses of styrene monomer are concerned synthetic rubber production obviously has first call. We are reasonably certain of meeting the military demands for polystyrene, especially where this plastic is required for electrical insulation. The only grounds for hoping that this plastic may be available for any civilian uses is dependent on the possibility of unbalanced production of styrene and butadiene which would leave an excess of monomer.

Monomeric vinyl acetate has been the limiting factor in the production of most vinyl polymers since the early fall of 1942 and by July 1, new capacity should give us sufficient vinyl acetate monomer to meet practically all requirements.

Polyvinyl acetate resins and emulsions have been increasingly available for civilian use, especially in adhesive applications where these products are proving very successful in replacing or supplementing latex adhesives as in shoe manufacturing.

Polyvinyl chloride resins containing above 92 percent vinyl chloride are available in quantities to take care of all projected military demands and are limited for civilian uses only by the availability of suitable plasticizers and, to a lesser extent, by solvents required for certain types of operations. There are considerable quantities of good quality scrap from polyvinyl chloride resins, both plasticized and unplasticized.

Polyvinyl chloride acetate copolymers are available in ample quantities to serve all military uses and, for the past 3 months, have taken care of certain essential civilian uses.

Vinylidene chloride has a broad list of end uses, ranging from essential civilian applications in the replacement of copper, brass and tin, to direct military uses which are growing steadily.

Barring unforeseen developments, the amount of synthetic phenol available for plastics is expected to be approximately 30 percent more than at present. Since there are many new and large prospective war usages, there is considerable doubt that the materials will be available for any but the most essential uses.

The melamine-formaldehyde resins have been limited by the available melamine, and by the end of July there will be approximately 50 percent more of this material than at present.

J. A. LAWSON

The availability of the urea-formaldehyde plastics is dependent upon the capacity for urea crystal which cannot be readily expanded, and upon the amount of formaldehyde which can be provided. The urea adhesives are expected to be used in larger quantities for waterproof corrugated carton production but it is believed that all military and essential civilian requirements for adhesives and molding materials can be taken care of as soon as we get new formaldehyde capacity now under construction.

Vulcanized fibre has recently been placed under allocation order M-305. It is believed that all military and industrial requirements, as well as the needs of our allies can be furnished.

Casein now is being distributed under M-307, and the demand is considerably greater than the supply. Domestic production will not be very great because of the demand for milk for edible products, and shipping space will allow only enough importations from Argentina for military and essential civilian requirements.

Mr. Rector warned that the threat of increased man-power difficulties lurked as a spectre over any unessential usage. He advised the industry to concentrate on usages necessary to the winning of the war and suggested the employment in some areas of female help. He suggested the advisability of having one or two alternate materials for uses of secondary essentiality so that the most available may be used for maintaining production.

Major Edwin L. Hobson, the second speaker on the program, presented an exhibit of samples in connection with his discussion of *Plastics in the Quartermaster Corps*. He expressed the appreciation of Major General Edmund B. Gregory, The Quartermaster General, for the invaluable aid of the plastics industry in meeting the sometimes extraordinary demands of the Quartermaster Corps for the many plastic items produced and fabricated.

Major Hobson spoke of the Research and Development Branch that has been set up in the Military Planning Division, Office of The Quartermaster General, in order to develop and improve the many items of Quartermaster Corps equipment. Here, he said, are assembled, under Col. Georges Doriot, more than 200 leading industrial engineers and experts, explorers and scientists. This Research and Development Branch is divided into functional and industrial sections such as Mechanical, Rubber, Textiles, Leather, Clothing, Subsistence and Plastics. The Plastics Section is charged with the research and development of all items utilizing plastics as well as maintenance of the raw material supply. In the Quartermaster Corps, plastic means not only molding resins but paints, varnishes and lacquers, coated fabrics, impregnated papers and synthetic rubber.

Major Hobson explained that before ideas on plastic items are passed to the industry for development they are evaluated as to military necessity. When an item meets requisite military characteristics, it is standardized by the Quartermaster Corps Technical Committee after which specifications are prepared.

It is always possible to change specifications on any item so long as the alteration can be made without detracting from the military characteristics. Major Hobson stressed the importance of making requests for changes on existing contracts through the contracting officer at the procuring depot since the specification is part of the legal contract. These requests then are sent for approval to the Office of The Quartermaster General.

Major Hobson mentioned that today the Quartermaster Corps is procuring 40 items requiring the predominate use of plastics and 400 other items incorporating plastics. And to make these items alone, 75 million lb. of plastic material will be needed during 1943, about 10 percent of the total production in this country.

Major Hobson said that he found most interesting those plastic items that have been developed especially for the Armed Services. The cover, protective, individual or gas-proof cape he suggested as a good example, providing troops with protection against low flying planes, spraying liquid mustard gas or other vesicants. The British use an oilskin-type voluminous raincoat. This not only is extremely expensive, about $8 each, but was not available in the necessary quantities. Further, it was not considered entirely suitable. The cellophane industry was called in and the problem explained to it.

The design of the cover was worked out and an extended test at the Infantry Board including simulated actual conditions, was conducted. All this, Major Hobson emphasized, in 2 months' time.

Other plastic items which Major Hobson suggested as being of equal interest are the raincoat, bugle, knife handle, helmet liner, rainsuit, canteen, waterproof match box, food bag, delousing bag, weapon cover, etc.

The next speaker at this session was James A. Lawson, Chief of Facilities Section, Chemicals Division, WPB, who spoke on *Machinery Order L-159*, and his work in metals formulae, design changes in machines and equipment, labor problems, procurement of additional facilities, etc. Order L-159 was originally a limitation order, Mr. Lawson explained, but on April 14, 1943, it was amended to function as an allocation instrument. Now when a molding company is allotted a machine, the manufacturer of this equipment will deliver it without rating and the sequence of delivery will be as of the date of order.

V. E. MEHARG

Mr. Lawson explained that manufacturers operating on this schedule will be allotted their raw materials on the CMP certificates and credit will be given in these certificates for lack of rated orders. Under CMP Reg. 5, he said, maintenance and repair items may be obtained up to $500 on a single order. However, no person shall use the allotment symbol or preference rating to obtain such supplies during any calendar quarter in an aggregate amount exceeding one quarter of his aggregate expenditures for such parts during the calendar year 1942. Exceptions, he continued, are persons engaged in seasonal business.

Following this speech there was a demonstration of *High Frequency Heating* by V. E. Meharg of Bakelite Corp. In his talk, Mr. Meharg covered substantially the same subject matter that appeared in an article previously prepared for MODERN PLASTICS (March 1942, p. 87).

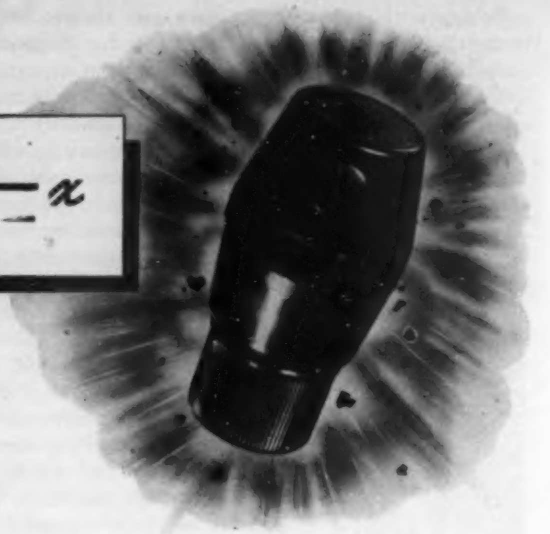
At 5:15 the sound and color film, *This Plastic Age*, prepared by MODERN PLASTICS magazine, was shown to two large audiences. Prior to the dinner meeting the entire organization was entertained by the Plastic Materials Manufacturers Association.

An innovation at the annual banquet was the dramatic Posting of Colors and presentation of the Manual of Arms by a group of U. S. Marines who appeared through the courtesy of their commanding officer, Lt. Col. Carlton Hill, U.S.M.C.

Highlight of the evening was a talk by Stanley Johnston, war correspondent and author of *Queen of the Flattops*. Mr. Johnston's subject was *War in the Pacific*, the thrilling story of the sinking of the aircraft carrier *Lexington*. The Convention came to a close with the installation of the newly elected officers followed by an acceptance speech by George Scribner, new president.

$\overline{69} \mp 247 = e - x$

by L. J. FALKENHAGEN*



THE cryptic equation above is perfectly clear to the reader when he learns that:

69 = the No. 69 plastic hand grenade;
247 = the No. 247 plastic fuse which complements it;
e = the explosion of the grenade; and
x = the unknown number of Nazis thereby rendered *hors de combat*.

It is also apparent to even the least mathematically minded that the greater the explosion, e, the larger x, or the number of defunct and disabled Nazis, will have to be in order to balance the equation. The quality of the grenade itself will naturally affect the intensity of the explosion and, assuming that the aim of the thrower is reasonably good, its corollary, the expended Supermen.

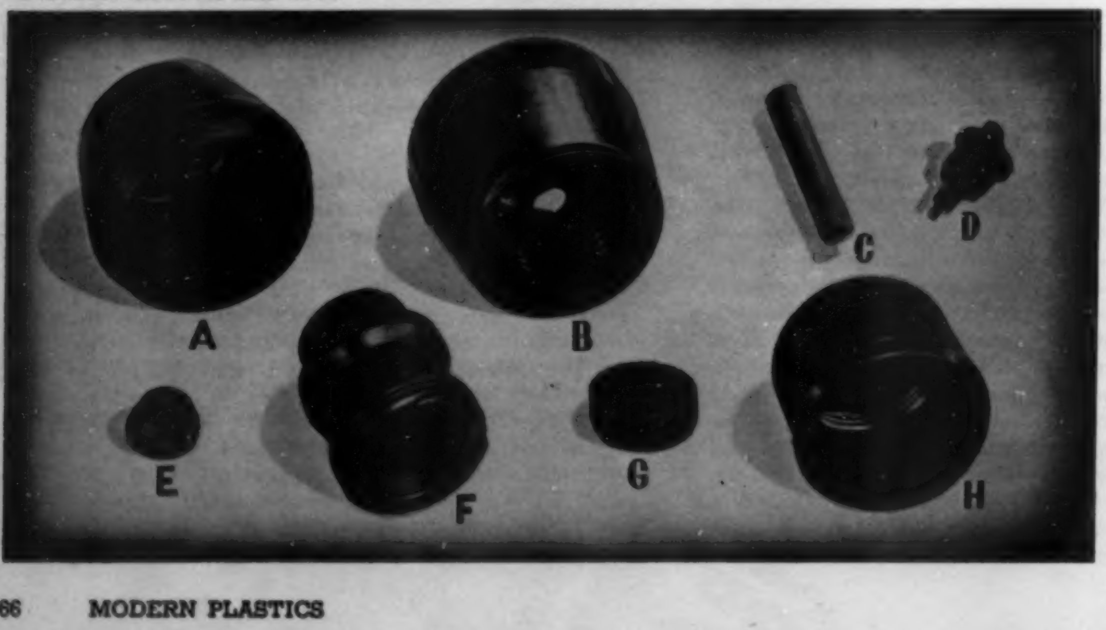
The Department of Munitions and Supply in Ottowa, Canada, knows that a goodly amount of damage will ensue from the explosion of this plastic hand grenade, now being used for training purposes within the Dominion, and filled there to be shipped for offensive operations. There is, of course, no shrapnel connected with the No. 69. It is purely a concussion grenade, filled with high explosive which is set off by percussion when it lands. In contrast is the Mills grenade of World War I, a fragmentation weapon made of cast iron which operates on the time principle. The advantage of the percussion grenade is that its victim, unlike that of the Mills grenade, cannot speedily leave the neighborhood before the fuse fires the detonator, or pick it up and toss it back.

The No. 69 grenade, together with the No. 247 fuse, is molded of medium impact cotton flock and woodflour filled phenolic material. As for all war matériel, requirements for such a weapon are severe. The material of which it is molded must be dimensionally and physically stable under extremes of temperature (usually $-40°$ F. to $+170°$ F.) encountered by troops fighting through a northern winter or in tropical climates. Its impact strength must be adequate to the functions of the various molded parts. Weather, water and mud must not destroy the effectiveness of the unit it composes, and it cannot affect, or be affected by, the explosives used in the grenade.

The hand grenade (above), so named because it was thought to resemble the French *grenade*, or pomegranate, is a missile some 4 inches long consisting of a container fitted with a priming charge and a bursting charge, and filled with high explosive. The No. 69 comprises four individual molded plastic parts—the upper and lower bodies and two small plugs—which are assembled with a phenolic impregnated paper tube and cemented together. Fuse No. 247 has three molded parts—body, closing plug and cap—and five metal parts: the striker, creep spring, cap pellet,

* General manager, Joseph Stokes Rubber Co., Ltd.

PHOTOS, COURTESY JOSEPH STOKES RUBBER CO., LTD.



1—*Molded parts of the plastic hand grenade: A and B, grenade body; C, paper tube; D and E, plugs; F, fuse body; G, closing plug; and H, cap of the grenade*

ball and safety bolt. Three rubber washers and a rubber plug complete the assembly of the grenade.

The upper and lower grenade bodies (A and B in Fig. 1, which shows all the plastic parts of both grenade and fuse) are compression molded of medium impact cotton flock phenolic, with an impact strength of 3 ft.-lb. energy to break. As these parts come in direct contact with the explosive, a special, chemically prepared material is required, one having no ingredients which may sensitize the explosive. The two internal and one external threads of part A and the two internal threads of part B are molded-in. Figures 2 and 3 show the molds for the upper and lower bodies, respectively, installed in the presses.

Also molded by compression are the two small plugs (parts D and E), both threaded parts which must fit exactly into the proper threaded holes in the body of the grenade. Woodflour filled phenolic is employed for these parts, and again chemical properties of the material have to be watched carefully in view of its contact with the explosive. Part C is a phenolic impregnated paper tube supplied to the molder by the fiber companies.

After they have been molded and the flash removed, the four body parts are screwed together, cemented and assembled with the paper tube which, cemented in the center, forms the detonator compartment. Several pressure tests are given the assembled bodies before they are shipped.

Part F, the body of the fuse, is a spool-shaped piece with an external formed thread on one end and both external and internal threads on the other. This part is transfer molded in 12-cavity molds, the 6 pots and plungers each feeding two cavities (see Fig. 4). The same medium impact, cotton flock filled phenolic used for the grenade body parts comprises the fuse body. The woodflour filled material forms part G, which is compression molded, as is the cap (part H), the latter composed of general purpose medium impact phenolic.

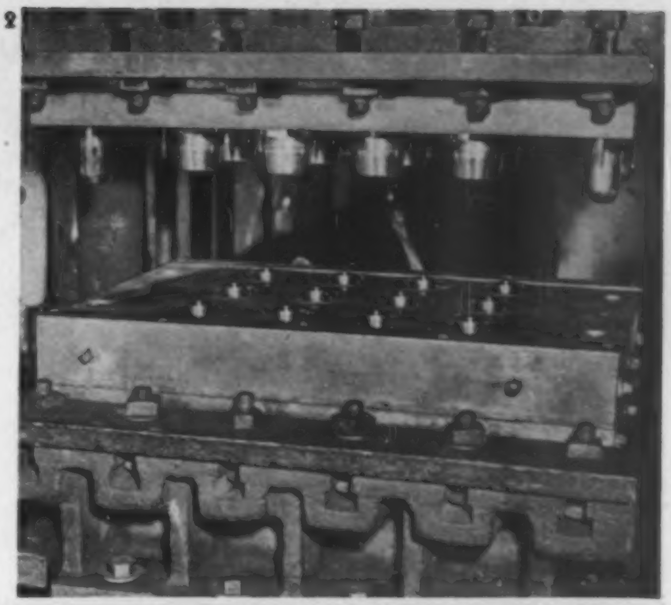
Because every plastic piece of both grenade and fuse has at least one molded-in thread, all parts must, of course, be held to very close tolerances. Rigid inspection of raw materials, semi-finished pieces at various stages of production and the completed parts is carried on as a matter of routine.

Sixteen molds in all are being employed for the production of the plastic parts of the No. 69 and the No. 247. Tonnages of the presses used range from 50 to 200, and platen areas vary from 15 by 15 in. to 20 by 30 inches. All materials are preformed by regular rotary and plunger type machines.

The prime contractor for the grenade is the molding company, one of the first plastics molders on the North American continent to act in that capacity for a completed war weapon. Only the five metal parts of the fuse are subcontracted, since the molding company also produces the rubber plug and washers. Although the weapon is almost an exact duplicate of a piece designed and produced in Great Britain, the materials, methods of manufacture and mold designs for the Canadian-made grenade were developed by the molding company and its material suppliers.

The importance of the hand grenade in military operations would be difficult to overestimate. The purposeful expression of a soldier in the act of hurling one (above) is testimony to the damage this plastic missile can inflict. An army without grenades and the men to throw them would be in the same sad circumstance as one Willibald Borowietz, a Nazi major-general captured in Tunisia, who is reported to have declared as he burst into tears, "I have no *Panzers*, no artillery—not even a grenadier."

Credit—Molder, Joseph Stokes Rubber Co., Ltd.

2


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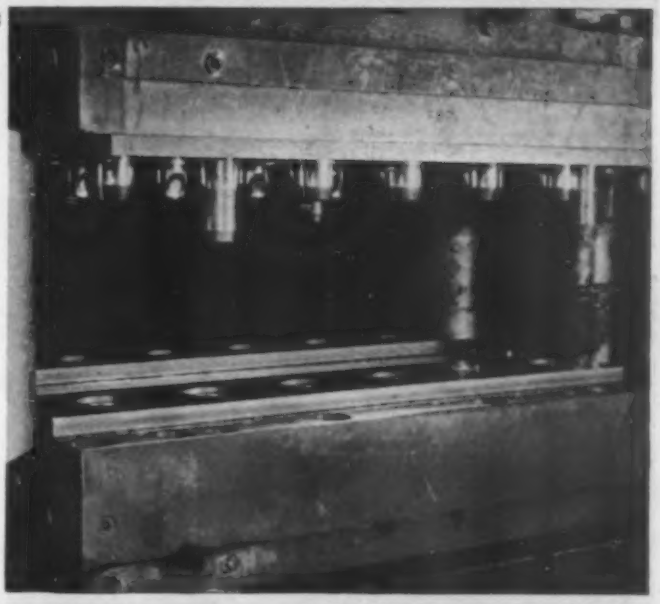

4


2—Compression mold for part A, the upper grenade body, installed in the press. 3—Mold for lower grenade body, part B. Also compression molded, the piece has two internal molded-in threads. 4—Transfer mold for fuse body, part F

The disappearing Marine

1


2


3


THERE was a time when a screen of branches held before an advancing line of foot soldiers could throw the enemy into a state of impotent bewilderment. But modern warfare with its high-powered lenses for minute observation of the opposing forces and its employment of aerial reconnaissance, has advanced camouflage to a science. Equipment and men must blend into the surrounding country, viewed from every angle. In the case of personnel camouflage, the same equipment must serve in the jungle as well as on the desert. And not only must every type of background be considered, but every caprice of the weather. Penetrating fog, torrential rain, suffocating damp, blanketing snow—these garments must be able to withstand them all.

For this grueling duty the United States Marines now are provided with ponchos manufactured from 2 layers of lightweight, water-repellent cloth bonded with a polyvinyl butyral resin filler. The same resin serves to cement the poncho's seams. In employing this plastic, originally developed as a tough, resilient interlayer for safety glass, the specific purpose was to develop a rubber substitute.

Early in 1940, long before the rubber shortage developed, the Army Quartermaster Corps was working on improved waterproof material for enlisted men. In the last war there was a "raincoat scandal" in which the Government charged a group of manufacturing companies with the use of poor cloth and rubber and with failing properly to cement the seams. The resultant product was described by a high military official as "rotten." For the raincoat of soldiers in World War II, the QMC turned to synthetics to overcome the tendency of oil-treated coating to crack readily at low temperatures, become sticky in hot weather, and of rubberized garments to deteriorate under extremes of temperature.

The Marine poncho which serves as a raincoat or half of a 2-man pup tent, may be camouflaged on one side to blend into the jungle foliage and on the other to match a desert or winter landscape. Regular khaki coats sometimes are specified. The 2 sheets of high quality lawn made from combed cotton yarns first are printed with the camouflage design, then bonded with the polyvinyl butyral filler.

This plastic was developed especially for such war requirements as raincoats, hospital sheeting, gas protective fabric, drinking water bags and life-preserver jackets. It has many of the same characteristics as rubber, can be cured or vulcanized much like rubber and is handled on the same types of machinery with the same techniques as rubber. This means, for manufacturers of water-proofed fabrics, no new equipment and no additional training for labor.

While not suitable for tires, this new formulation can be molded into heels and extruded into tubing. However, all available supplies now go only to the military.

Credits—Materials: Saflex. Ponchos manufactured by Archer Rubber Co. for the U. S. Marine Corps

1—Standing erect in his new poncho of plastic-bonded cloth, this Marine resembles an alert zebra. 2—Squatting in the jungle, he can scarcely be told from the foliage. With poncho reversed, he's a piece of desert or a patch of snow. 3—The water-repellent poncho makes half of a pup tent just large enough for two congenial comrades

Thermoelastic C-Stage laminates

by E. F. LOUGEE*

PHOTO, COURTESY NORTH AMERICAN AVIATION, INC.

1—Surrounded by molded and fabricated plastics airplane parts, Chief Engineer Beach holds in his hand a molded canvas-filled bomb rack. Note at upper right a 4-ft. fuselage tail wing fairing panel assembly formed from two sheets of C-Stage phenolic canvas base laminate

TODAY'S aircraft plastics engineer is no theorist. He is a hardworking member of every aircraft manufacturing organization and intensely serious about his job. He has anywhere from 4 to 30 assistants under his immediate thumb besides all the help he can chisel from the mock-up and woodworking departments. You will find him working intimately and harmoniously with other engineering branches of the organization, with more and more responsibility being placed upon his shoulders as he demonstrates the value of his research and application of plastics to production problems.

He has made mistakes and profited by them. He has made discoveries never thought of by plastics engineers outside the aircraft field, and he has put them to work in a matter-of-fact way. He knows now that plastics are not substitute materials. They are either better than the materials they replace or they don't get in. "Better," in this instance, means that plastics materials must make some advantageous contribution—either in performance, or saving of weight or cost—to the part under consideration. Also, they must offer no greater problem of fabrication or assembly than is encountered with a comparative metal part. They must be as strong or stronger by every test and have equal or better use-life in every respect.

With this set-up, plastics are getting a real chance to show what they can do; thousands of tons of precious metals and man-hours are saved; and a better product is produced.

* Chairman Advisory Board, Plastics Institute.

There is an average of 200 plastics parts in today's fighting ships of the air. This is no secret. Many of them are conventional electrical insulators, instrument details or housings, communications equipment, aileron pulleys, fairings, cams and bushings that have been used for years. We needn't dwell upon these because everyone knows they are doing their job well.

At the same time, we should give credit to the satisfactory performance of these well-known plastics devices for some of the enthusiasm generated in extending their use into more complex engineering replacements just coming to light.

Who but an aircraft engineer would think of taking fully cured phenolic canvas laminated sheet and forming it into intricate shapes without any press equipment other than a few clamps? Chief Plastics Engineer William Beach of North American Aviation, Inc., in conjunction with associates Robert Whann and Algot Peterson, is responsible for this paradox, discovered while monkeying around with laminated phenolic canvas sheet universally used as electrical insulation.

This set Beach to think about several problems that had been dumped on his desk to solve. One was to produce a plastics ammunition chute, ejection hopper and ammunition box, which were in their present state constructed of aluminum or steel. The hopper, made of aluminum (Fig. 2), has to be seam-welded from four separate stamped parts to form the deep draw. It requires a plastics lining to protect it

from abrasion and denting when the empty shells come whamming out of the gun at the rate of 100 or more a minute while it is in action. Now this hopper is made in one piece of plastics laminate in less than three minutes with a saving in both weight and cost. Since it requires no liner, the weight of this unnecessary piece is saved 100 percent.

The 7-ft. ammunition chute (not illustrated) must be accurate in dimension and perfectly smooth to promote rapid uninterrupted flow of ammunition. One small dent in a metal chute and the ammunition may be retarded, or jam and cease to flow. Furthermore, the chute has to be twisted almost at right angles when installed and this always presented a difficulty with metal. The metal chute has to be twisted in fabricating so it will fit perfectly in place. The laminated phenolic chute is made flat and simply twisted to fit as the installation is made. The time saved is obvious.

Time is not the only saving, however. In conjunction with the chute and hopper there are an ammunition feed chute (Fig. 4) and ejection box (not illustrated), usually made of stainless steel. When stainless steel became scarce, laminated phenolic sheet was fabricated in its place. It was soon found that the laminate was not so inclined to scuff in contact with the shells as steel. Therefore, it did a better job of performance. It also saved cost and weight.

At first, these chutes were fabricated from flat sheets (Fig. 4) fastened together with vulcanized fiber strips which could be softened and shaped by steam. Some ammunition boxes and hoppers are being made entirely of vulcanized fiber but not at North American.

"It picks up too much moisture and warps badly," says Beach.

In fabricating from flat stock, the fiber strips had to be riveted, which required both metal and time. So when Beach found that he could form plastic laminates as rapidly and economically as vulcanized fiber and bond the overlap with a bonding agent, he concentrated on this type of research.

Some months of experimentation have transpired during which a lot or problems have been worked out. Getting compound curves without fracturing the canvas fibers was one of these.

The material is often ribbed or beaded in forming to increase its stiffness. This may be seen clearly in Fig. 3, where the part is flanged at parallel edges as well as around the hole in the center, and two depressions are formed at right angles to the flanged edges to give added stiffness to the part.

The most important implications of the process include such vital factors as low cost of equipment, which can be quickly made from non-critical materials; no heavy press equipment which would be impossible to obtain; and the simplicity of the process, which depends upon proper handling rather than highly skilled help. I am not at liberty to reveal greater details at the moment, but a complete technical disclosure is promised in the near future to readers of this magazine.

The novelty of the process is quite clear. C-Stage phenolic laminates have been considered in the past as fully cured thermosetting materials, non-fusible and non-soluble. Existing properties charts list the softening point of cotton fabric base phenolic laminates as "None." One is led to wonder, therefore, if there is such a thing as thermoset laminates. Formed parts can be re-shaped again and again, according to Mr. Beach.

"I prefer to think of the material as *thermoelastic*," says Mr. Beach, "because it can be drawn and made to stretch or elongate. In shaping the hopper, for example, we not only shape the sheet into a complex form in one operation, but we draw it to form an inch or more of overlap which is subsequently riveted to hold it in true shape."

The process, patents for which have been applied for, has been extended to other parts such as accumulator covers, aviators' chart cases, fuselage tail wheel housing 4 ft. long, wing gun ammunition feed chutes and ejection chutes, several of which are shown in Fig. 1. A number of these items are in production as this is written, both at North American and at independent fabricating shops. The company, at the request of various vendors, has licensed them to form this material.

Besides forming C-Stage laminates, North American uses a great many molded parts. Most prominent perhaps is the bomb rack molded of canvas filled phenolics shown in Fig. 1. This actually supports a heavy bomb and is a structural member which supports a concentrated load. (*Please turn to page 148*)

ALL PHOTOS, COURTESY NORTH AMERICAN AVIATION, INC.

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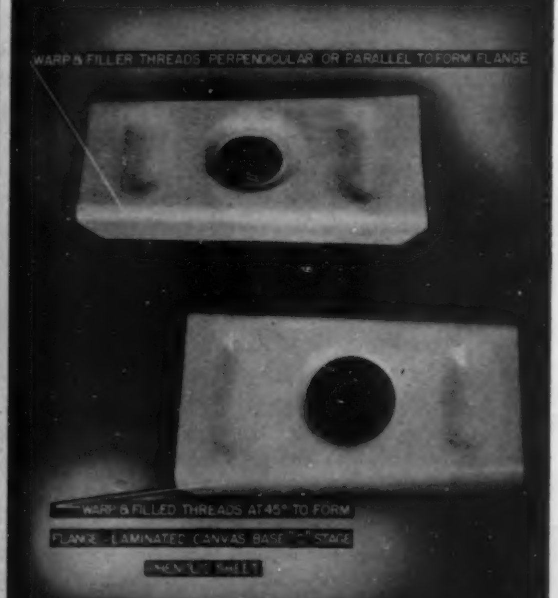

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2—*Ejected ammunition hopper formed from one-piece laminated C-Stage fabric base phenolic sheet (left) and its metal counterpart (right) made from 4 stamped aluminum parts, seam-welded at each corner.* 3—*Typical rib, showing lightening hole, bead and flange formed from C-Stage laminate in one operation.* 4—*Transition from metal to plastics of a wing gun ammunition chute: the metal part, 4 separate stamped pieces riveted together, appears at right. First step: chute fabricated from flat sheet, using vulcanized fibre and rivets to hold separate sheets together (center). The redesigned part (left) is formed from C-Stage laminate in two pieces riveted together.* 5—*Ammunition box formed entirely from C-Stage phenolic laminate.* 6—*Same material forms a 30 caliber ammunition box showing sharp radii bends at bottom and ends.* 7—*Fixed gun case and link ejection chute fabricated from 4 parts (left), then formed in one piece with scarfed joint (right) from C-Stage phenolic canvas base laminated sheet.* 8—*Cable guard, compass mounting bracket and trim tab link fairing. Formed C-Stage phenolic laminate replaces aluminum*

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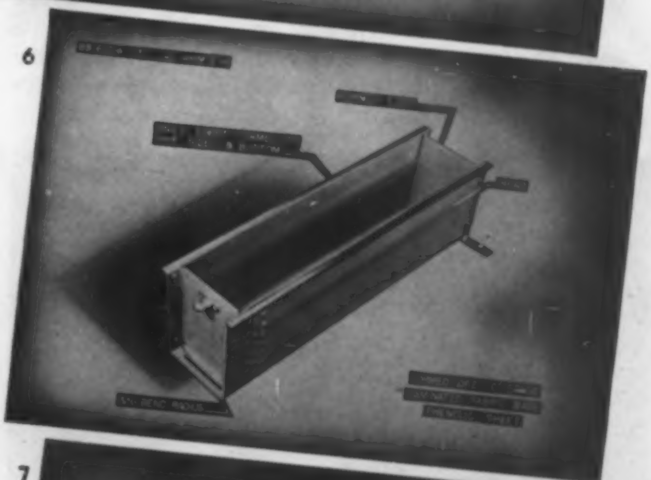

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OFFICIAL PHOTOGRAPH, ARMY AIR FORCES

Fittings for the Thunderbolt

FASTER than sound—725 miles per hr. or 12 miles per min.—that's the record two daring Army test pilots established by power-diving with Republic's super-speed, super-powered high altitude fighting plane, the *Thunderbolt.* Here is an almost unexplored aerodynamic horizon and speed frontier attained as a result of an excellent integration of design, engineering construction, and the utilization of the most modern technical knowledge, equipment and materials. Even the comparatively small percentage of plastics materials which contributes to the structure represents an achievement, for the structural soundness of the entire unit bears testimony to the efficient functioning of each minute part.

The plane itself, built to stand terrific stress but designed for split second maneuverability, is a snub-nosed brute powered by a 2000 h.p. Pratt & Whitney 18-cylinder radial engine, which with the aid of a turbo-supercharger and with an installed oxygen supply for the pilot, will rise to 40,000 feet. It performs at more than 400 miles per hr., and has been known to dive at 725. From wing tip to wing tip, the P-47 measures 40 ft., $^5/_{16}$ inches. Distance between lowered landing wheel to the top of the four-bladed Curtiss propeller is 12 ft. 4 $^{11}/_{16}$ in., and the distance between landing gear wheels is more than 14 feet. Eight .50-calibre machine guns are mounted in the wings outside the sphere of rotation of the propeller.

In numerous places throughout the *Thunderbolt*, plastics play major and minor rôles, serving wherever they have proved that they can save weight, provide strength, and make possible rapid, economical production. Cockpit enclosures (except for the windshield) are of transparent methacrylate sheet, nameplates are of molded and laminated materials, handles and knobs are plastic, some of the pilot seats are of plastic-plywood, laminated and molded units serve as essential insulating equipment in countless instruments. For example, laminated sheet is employed in the engine cowl, where strong, flexible wedge-shaped sections serve as cowl flaps, thus keeping the air flow uniform as the metal cowl flaps open for cooling.

One of the most unique uses for plastics is the cockpit ventilator pictured in Fig. 1, molded of a high acetyl

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1—Cockpit ventilator injection molded of Nile green cellulose acetate. Top to bottom: vent nozzle, assembled unit, two halves of body, extruded tube used in fastening device. 2—Machine gun rollers installed in plane wing

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PHOTO, COURTESY REPUBLIC AVIATION CORP.

cellulose acetate. This ventilator has two main sections: the body or cockpit unit, which is a long elbow-shaped tube and the cockpit vent nozzle, a shorter straight tube which dovetails with the body of the unit at right angles. The vent tube lies along the floor of the cabin and connects with a duct which is an integral part of the leading edge of the wing. This induces air into the vent tube but the air supply can be cut off by closing a metal shutter within the duct placed at the point where the fuselage meets the wing. The vent nozzle stands upright, parallel with the pilot's legs, so that he may kick the nozzle either backward, forward or straight up in order to direct cool air wherever he desires it.

The body of the piece is injection molded in two halves, each half produced in a 30-sec. cycle on an 8-oz. press at 22,000 p.s.i. pressure. To assemble the halves, they are held together by clamps in a vertical position and then cemented by pouring acetone along each seam with an eye-dropper so that the acetone flows smoothly down the molded grooves which form the edges. A small extruded plastic tube, $^{13}/_{32}$ in. in diameter cut to $2^1/_4$-in. length fits into the cylindrical end of the cockpit vent acting as support through which a pin is placed in order to fasten the nozzle section to the body.

The cockpit vent nozzle is produced in a single-cavity injection mold over a core which naturally forms the tube. The material is ejected right over the core which slides into the mold. When the mold is opened, the core is lifted out and the nozzle slipped off.

The plastic assembly weighs 1.14 lb. complete and replaces a complicated welded aluminum unit which weighed 1.62 pounds. The latter also proved more expensive because it took twice as long to produce, due to the highly skilled labor required and the elaborate finishing and assembly. The plastic pieces are rapidly secured from machines operated by previously untrained girls, require no finishing other than the removal of the sprue and 200 complete units are turned out 24 hours after molding.

Incidentally, the color of the piece is a Nile green to match most of the painted surfaces inside the cabin interior, and the plastic will stand a lot of rough wear—even from the pilot's No. 12's—and won't chip, dent or split.

The same molder produces cellulose acetate machine gun rollers (Fig. 3) which feed the ammunition to the guns mounted in the wings. These are made in two sizes, 10 of each injected in a 20-cavity mold on a 35-sec. cycle. The only finishing required for the rollers is removal of the gates by tumbling. The plastic rollers replace machined metal pulleys which were heavier and considerably more costly, and which did not match the plastic rollers in abrasion resistance, toughness, and smooth, permanent finish.

Cellulose acetate reaches from wing tip to wing tip—not a continuous line, but in the form of protective covers for wing tip lights (Fig. 4). These lightweight, transparent sections formed from .101-in. thick sheeting have a hard surface, can be wiped clean with a damp cloth. The plastic light covers are triangular in shape but rounded to conform with the contours of the wing.

This same plastic supplies both inner and outer insulation for small plugs used in communication equipment, which are supplied to Republic by the U. S. Army Signal Corps (Fig. 5). The cap or shell is capped cellulose acetate tubing, the separator shown in the cut-away section (second from left) is machined from cellulose acetate rod. These plugs, about 2 $^{13}/_{16}$ in. long and $^1/_2$ in. in diameter, have been produced of phenolic resins and hard rubber, but the manufacturer reports that cellulose acetate works best on high speed machinery because of its machinability, and because it is easier on tools.

Still another and extremely interesting plastic replacement planned for the *Thunderbolt* will eliminate an expensive metal unit. Not yet in production at this writing, we understand, this piece, an anchor-shaped cellulose acetate butyrate assembly, will serve as a windshield defroster.

Here in the newest Army fighter, aviation engineers have found and are continually looking for new ways in which to utilize the unique properties which plastic materials present. And as long as aviation engineers maintain the policy that has made the justified reputation of American airplanes—that of continually improving and altering design in order to take advantage of new knowledge, techniques and actual combat experience—we can expect that plastics will be found worthy for many jobs for which they alone are suited.

Credits—Material: Lumarith. Molders: Cockpit vent, machine gun rollers—Pyro Plastics Co.; Plugs—W. A. Sheaffer Pen Co.

3—Injection molded acetate rollers which feed ammunition to guns mounted in wings. 4—Covers for wing tip lights are formed from transparent acetate sheet. 5—Plugs used in communications system, insulated with cellulose acetate

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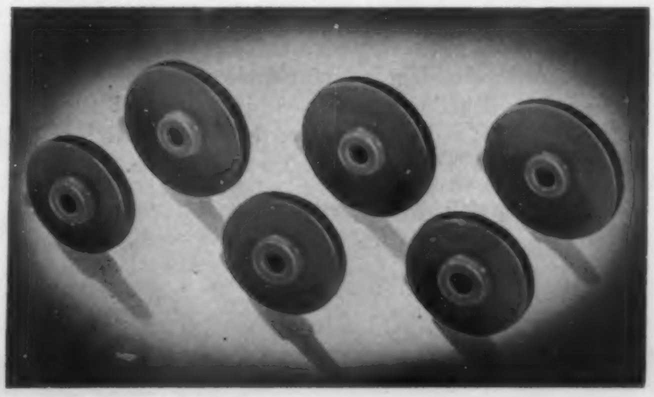

PHOTOS, COURTESY CELANESE CELLULOID CORP.

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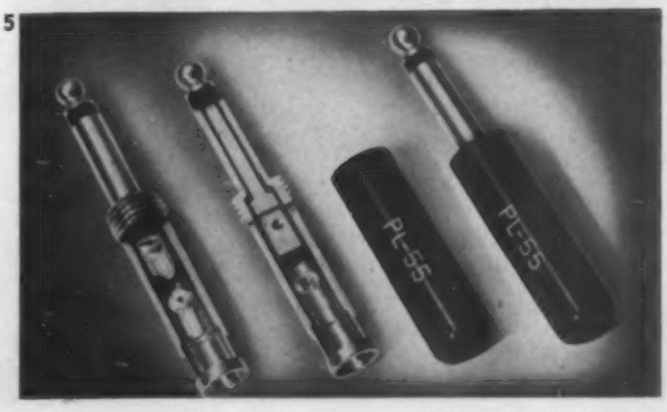


Product

High-altitude test chamber

"Seeing is believing" is the slogan of engineers testing aircraft radio and electronic equipment under conditions duplicating the stratosphere $7^1/_2$ miles up. In the past, using test chambers constructed of metal with heavy, low-visibility glass windows set at infrequent intervals, this has meant repeated shifting and remounting of the apparatus under test to permit complete observation of results.

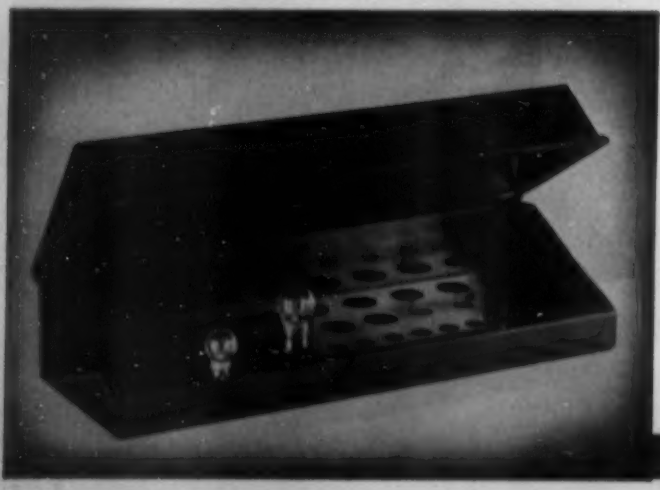
It was a bomber nose into which radio apparatus was being installed that gave engineers of the radio equipment company the idea for a new altitude test chamber built of transparent acrylic sheet which would permit complete testing by several engineers in a single operation. Cone-shaped, about 4 ft. high and 5 ft. in diameter at its base, this chamber is made from sheets $^7/_8$ in. thick reinforced with heavy but transparent ribs.

An air-tight seal is obtained by fitting a heavy platform, arranged for mounting radio apparatus under test, with a ring of soft rubber. The transparent cone then is lowered until its base rests on the rubber ring. Air is withdrawn by a high-speed vacuum pump which causes the outside atmospheric pressure to force the chamber down into the rubber ring to create a perfect air seal.

Credits—Material: Plexiglas. Fabricated by Rohm & Haas Co. for RCA Victor Div., Radio Corp. of America.

Spare lamp box

With a myriad of illuminated instruments and tiny lights to be kept in working order, the big bombers must be equipped with extra bulbs to replace any which may be put out of commission. Thirty-seven of these fit inside a sturdy, compact molded plastic box, constructed to accommodate a maximum number of bulbs and at the same time to protect them adequately. Replacing a complicated and heavily insulated metal assembly, the plastic unit consists of a molded cover and base, assembled with a unique hinge arrangement and padded with three strips of sponge rubber. The latter fit into three sections, separated by bars molded right into the base and held in place by a sheet of laminated phenolic fabric sheet which, fastened to the base by 6 drive screws, forms the bottom of the box.



Both cover and base are molded in single cavity molds on a semi-automatic press; molds are operated alternately and a complete box is obtained every six minutes. Wood-flour-filled phenolic is used for both cover and box, and the latter incorporates, in addition, a high-impact, macerated canvas phenolic compound introduced into the mold as a second loading in and around the back of the box for reinforcement of the hinge sections.

The hinge lug on the cover is molded with two flats. The female portion of the hinge in the bottom has a $^5/_{16}$-in. diameter hole approximately $^3/_4$ in. long into which is assembled a spiral wound spring and a round metal rod about $^1/_2$ in. long. The spring acts to force the small rod against the flats on the hinge lug, thereby holding the cover fixed in either an open or closed position, and eliminating the need for any additional clips or fastening devices.

The unit is light in weight—cover is $^4/_{16}$ oz. and the box, 12.25 ounces. Each of the holes is constructed like the actual socket into which the bulb fits when in use.

Credits—Material: Durez and Coltwood. Molder: Colt's Patent Fire Arms Mfg. Co. Design and assembly, Glenn L. Martin Co.

Development

Map and data case

Low-pressure molding technique, one of the plastics industry's brightest war children, makes possible a new lightweight map and data case for aircraft. This plastic unit weighs approximately 1 lb. and is reported to have exceptionally high impact strength. The box is made of bootleg duck (durable cloth formerly used for lining the insides of rubber boots), impregnated with low-pressure phenolic resin whose fast curing time is accelerated by the use of a catalyst. The box is produced in a single-cavity mold, under 150 to 250 p.s.i. pressure.

The cover of the box is made from enameling duck and manufactured in the same fashion as any other high-pressure laminate, except that it is gap-molded in order to produce a hinge; that is, strips of the laminate are not touched by the mold and remain uncured as shown, thus providing a flexible section which can be bent. This eliminates the necessity for assembling a separate hinge, reduces cost and production time. The cover is riveted to the box with 5 tubular rivets. These 5 rivets and 6 metal grommets are its only metal parts.

In addition to its economy, great strength and ease of manufacture, the box possesses the unique properties which phenolic resins can impart—resistance to weather, chemicals, acids, solvents, heat and moisture; it can be wiped clean.

Credits—Resins: Catavar. Manufacturer: Daystrom Corp.

Marking plates

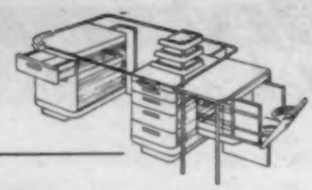
Just as every U. S. service man wears a dog tag, so each piece of equipment used by the armed forces customarily carries some sort of nameplate. Many of these identifying plates, formerly made of metal, are today manufactured of plastic materials. One large producer of plastic nameplates for Army and Navy equipment has developed a process of applying lettering by heat fusion, employing a brass embossing plate on preheated thermoplastic sheet stock—a method which obviates the use of expensive dies. The company's output includes nameplates, instruction plates, caution plates, direction plates and dials for Army and Navy aircraft, mechanized equipment and Naval vessels.

The type of plastic material used and its treatment depend upon the application, and upon the required resistance to high and low temperatures, chemicals, humidity, salt spray, gasoline, alcohol, coolants, oils, greases and in some cases acids and solvents. Among the thermoplastics to which the embossing process has been applied are cellulose acetate, cellulose acetate butyrate, vinyl chloride-acetate, ethyl cellulose and nitrocellulose. Most of these have heat resistance up to 175° or 200° F. In applications where higher resistance is required, the thermosetting plastics are employed, including phenolic laminated paper base materials, linen and canvas base phenolics, and ureas.

Plates are supplied to varying specifications with regard to tensile strength and flexibility, some being quite rigid while others are very flexible. Some have exacting requirements as to ability to withstand punishing shock and vibration. All plates are given special chemical-resistant coatings to meet special requirements. The majority have a black base with white lettering, although in some cases colors and contrasting colors are used, both for the base and for the lettering. For some Army requirements the lettering is fluorescent, phosphorescent or radioactive.

Credit: Nameplates by Burkhardt Co.

The future of product design



by PETER MULLER-MUNK*

UNLESS we are satisfied to live blindly from day to day, we must constantly analyze our position at the present to prepare for the problems of the future. Peace and war are not two isolated and disconnected states. The rain of the bombs over Pearl Harbor was anticipated by those that fell on Spain in the years preceding 1941. The shape and duration of the coming victory and peace are already forecast in today's enlarged production and in the demands of global strategy. It is, therefore, not idle to try to look at the past and find in it the germs of the present—and in the present, those of our future. Certainly, war is not an end in itself, as the Führer proclaims, but the terrible price we must pay to gain control over the peace for which we are fighting. We cannot permit ourselves to drift from our unpreparedness for war to a peace for which we are equally unprepared. The stakes are too high. This is the time for us to appraise our procedures and policies to discover the rules which will govern them tomorrow.

The industrial designer of today lives and works in a period of adjustment, of inquiry into his status and of high hopes for his future. His problems are quite naturally related to those of industry because the future of industry is his own future. I believe that a discussion of design and design practice is not merely a selfish dissertation of limited interest, but a very vital search into the pattern of industrial management and manufacture. Industry and design cannot live without each other and will continue to be bound together by their mutual need. If we can find the answers to the questions surrounding design we will also begin to lay down certain precepts for those perplexing industry. Here are three simple questions which must be answered:

* Product Designer and Associate Professor of Industrial Design, Carnegie Institute of Technology.

1—Herbert Hartman has designed a mobile canteen for factory workers which invites inspection and purchase

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1. What was the status of design before Pearl Harbor?
2. What permanent changes, if any, is the war having on design?
3. Under what conditions may the designer operate after victory?

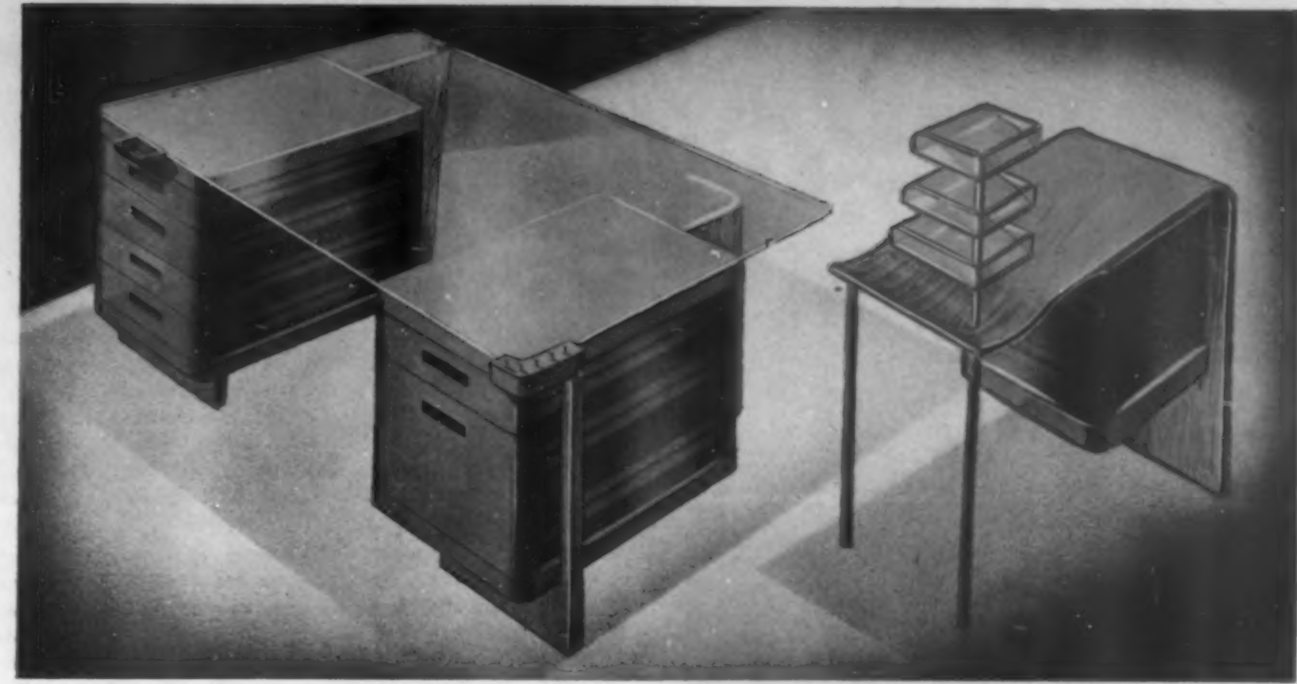
The period before Pearl Harbor was mainly dominated by a slow groping for professional standards and by the vices and virtues of competition. Industry discovered that the designer was a practical tool through which to win the consumer's favor. The designer contented himself mainly with injecting "style" into the products of the engineer and the public accepted "streamlining" as the hallmark of modern appearance. Plastics were among the favored materials of the designer, partly because of their real physical and visual qualities, and partly because of good salesmanship by the industry. By and large, industrial design concentrated on consumer goods and no very definite standards of accomplishment existed except those furnished by the sales department and the advertising value of a designer's name.

Somewhat like unlimited gasoline for our cars and butter for our tables, design was to many of us an unquestioned byproduct of a "fuller life." Nobody quite knew whether it was merely another "necessary" American luxury of peacetime competition, or whether industrial design was really a new profession essential to industrial progress. Here and there beginnings were made in serious thinking and attempts made at establishing tangible standards of knowledge and performance. Some designers and a few educational institutions treated design as more than a "frill" and attempted to go beyond the shallow cult of "streamlining." It is indicative of the public attitude that a lawsuit in the State of New York centers on the question of whether industrial design is to be interpreted as a business, in which anyone with enough luck or money could buy an interest, or as a profession based on definite fields of knowledge.

The photographs on these pages illustrate some of the postwar design work done by students at the Carnegie Institute of Technology. Figure 2 offers to the executive of the future an office desk which is light, clean, easy to assemble and simple to move. The filing cabinet which supplements it puts personal files within easy reach and provides an additional flat surface on which folders can be spread out. Its pivoted correspondence trays can be pushed aside when not in use.

The wide, deep desk well allows plenty of knee and foot room, and charwomen will have no difficulty in keeping the floor beneath spick and span. Also in the interests of cleanliness is the location of the ashtray, which guards against unfortunate desk-top conflagrations. All wiring for telephone, office intercommunication, dictaphone, etc., is concentrated in a control panel at the outer edge of the desk top.

The drawers and the units into which they fit are of injection molded and extruded cellulose acetate butyrate and compression molded phenolic, and wiring panel and ashtray are also of butyrate material, molded by injection.



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Molded plywood forms the desk supports. The desk top is of glass and some metal is used for braces and miscellaneous hardware, but otherwise the entire assembly consists of plastic materials.

Factory workers can be served with maximum efficiency by the mobile canteen shown in Fig. 1. Packaged and loose edibles are in full view of the hungry customers through the transparent cellulose acetate windows, whose channels are extruded of the same material. Framework of the unit is laminated maple covered with resin-impregnated fiber pulp sheet material, and the wheels are molded of high impact phenolic. All knobs are of cast phenolic resins.

A four-part lighting unit for both direct and indirect ceiling illumination which is easy to assemble and pleasing to the eye is shown in Fig. 3. A methyl methacrylate cr cellulose acetate reflector disk provides the direct lighting, while the indirect illumination is shed by a urea-formaldehyde reflector. The former has a sand-blasted area on its reverse side to catch the diffused light from the center cup, which is molded of urea-formaldehyde.

Purpose of the gasoline pump (Fig. 4) designed for postwar manufacture is to afford access to automobiles on an arc as near as possible to 360°, and to reduce height to $4^1/_2$ ft. so that the motorist can get a good look at the computer dials. The vinylidene chloride hose operates on an encased reel which pivots on a double axis, both horizontally and vertically. The length of the hose can thus be reduced from the present 14 ft. to 7 feet. The computer dials of transparent methyl methacrylate are sprayed on the reverse side and edge lighted. Molded phenol-formaldehyde forms the re-set crank and hose nozzle, and the spherical reel enclosure of this pump is of molded plywood.

Plastics became almost the (*Please turn to page 144*)

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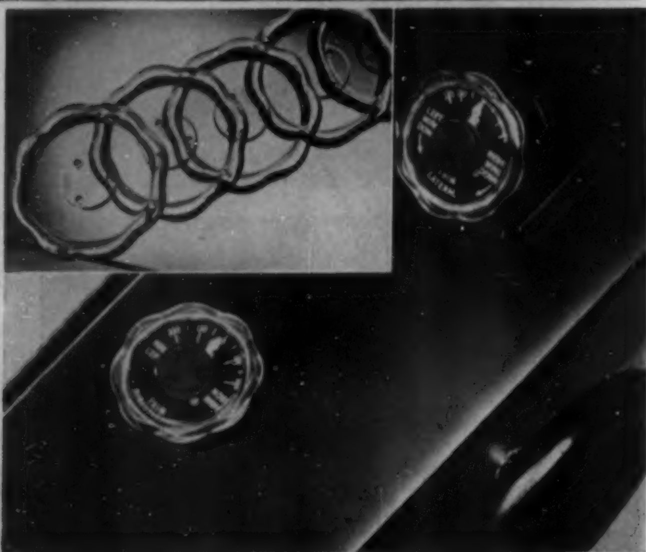
2—Phyllis J. Lester's office desk is light, clean, easy to assemble and move. Phenolic, butyrate and molded plywood are used. 3—A ceiling fixture with urea and acetate reflectors by Lt. Mark Sink. 4—Efficient gasoline pump designed by Cadet James G. Balmer, Jr.

PLASTICS in REVIEW



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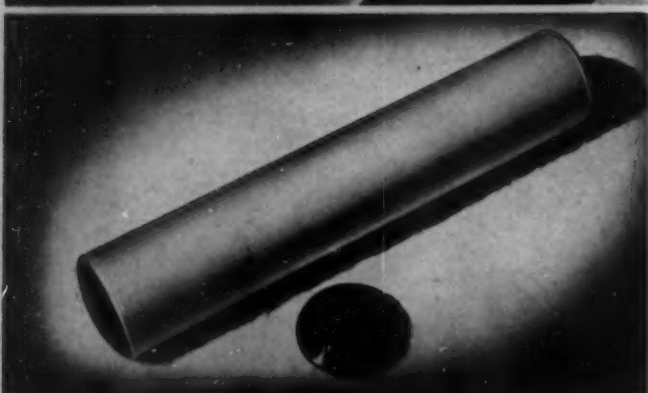

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1 Pilots of the Chance-Vought *Corsair,* speedy Navy fighter, can see that everything's under control through plastic wheel-shaped handles. Controls for rudder tabs and ailerons are manipulated with the aid of molded plastic wheels (inset) which permit a clear view of the dials and directions over which they are mounted. Smooth, durable, these plastic wheels are injection molded of Lucite or Tenite II, two at a shot, by Waterbury Button Co. Scalloped rim permits a firm grip for steady action. Close-up of the instrument panel shows these wheel handles in position

2 Developed to replace aluminum floats for Shand and Jurs Co.'s automatic gages for gasoline and oil storage tanks, these tubes are of Panelyte. The end pieces are molded from Bakelite in 2-cavity molds and affixed to the tubes with Catalin cement in the shops of American Molding Co. Four of these laminated phenolic tubes are clamped together, much like a raft, to form one complete float

3 "Enemy planes approaching." Our aircraft must be in the air in a matter of minutes. To insure that their spark plugs are ready for instant duty, Champion Spark Plug Co. ships them sealed at both ends with Lumarith plastic caps. These shields, which protect the plugs against dust and thread damage, are molded in 16-cavity molds by Peerless Molded Plastics, Inc., in a 30-sec. cycle with an injection pressure of 1600 p.s.i. The molds are interchangeable so that any of the three sizes can be produced in any one mold

4 Tiny little thumb pricks, yet upon these firing pins can depend the success of a military offensive. As essential to certain types of shells as the explosive and fuse, the pin has a shaft of metal alloy molded solidly into a head of tough medium impact Durez. Globe Tool & Molded Products Co. does the molding of these phenolic pins

5 Ruggedness is a prime requisite in equipment used by the Army Air Forces. The rim of Tenite II molded by American Molding Co. for Douglas Aircraft Co., Inc., not only imparts strength to the wheel but its ribbed surface improves the grip. Molded in two halves in single-cavity molds, the rim is then cemented over the six-spoke steel wheel

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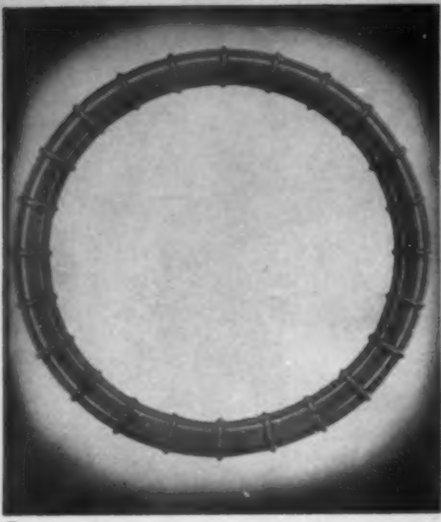

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6 With the outbreak of war, manufacturers of household equipment converted to war work. Having undergone this transition, National Pressure Cooker Co. has on hand a limited assortment of stock Textolite handles and thumb screws capable of a wide variety of uses. These phenolic parts are molded by General Electric Co. with inserts of cadmium plated steel

7 With the home once again the center of America's social life, indoor games are enjoying a phenomenal boom. Darts, an old and true favorite, recently underwent a face lifting to meet Government weight requirements. In redesigning darts, vanes were stamped from variously colored sheets of Pyralin and the head plugs fabricated of the same plastic. Innovation Products finds this change in material has increased the rate of production and prolonged service, since adhesion of needle to cellulose nitrate plug is stronger and the vanes less easily broken

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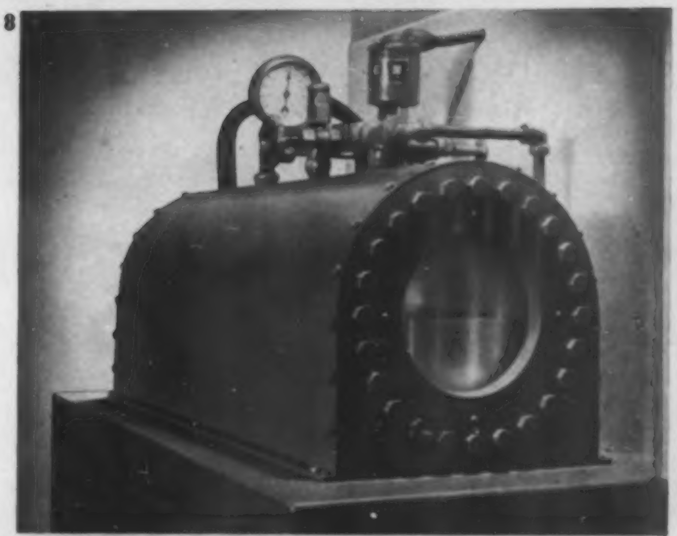

8 The public got its first glimpse of a large quantity of liquid CO_2 through Lucite windows placed in both ends of a miniature, mechanically refrigerated storage tank by Cardox Corp. The tank was part of a recent National Safety Congress display. The 1-in. thick methyl methacrylate windows were unaffected by this chemical, used to discharge fire-quenching "dry ice"

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9 In the race against time, these combination terminal lug insulators and wire markers are substantially speeding the assembly of wiring. Developed by Irvington Varnish and Insulator Co. from short lengths of extruded Vinylite tubing, these simple pieces are marked with appropriate letters and numerals, eliminating need of extra wire identification at the terminal connections

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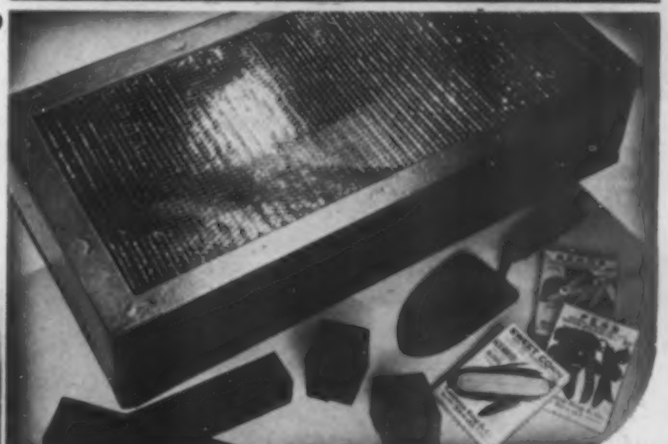

10 Planting time in America this second spring of the war is a serious venture. To assure our Victory gardeners a minimum of seed wastage, Wood Necessities, Inc., have developed "Grow-Aid" to cover the soil until the seeds have sprouted. But it is the plastic window, made by Flex-O-Glass Mfg. Co., that does the work. This material, a cotton mesh laminated on both sides with Lumarith, acts as a transparent blanket, keeping out the cold and heavy rain yet transmitting the ultraviolet rays of the sun

Army foot tubs

"All policemen have big feet" and all soldiers have tired ones! Plastic foot tubs filled with fungicidal solution keep their feet in good, healthy condition

PHOTO, COURTESY TENNESSEE EASTMAN CORP.

by LEE T. BORDNER*

THE saying that "an Army travels on its stomach" may be metaphorically correct, but any member of Uncle Sam's infantry forces will be glad to supply a much more literal—and considerably more colorful—version of how he covered that last twenty miles! Even with our motorized equipment, a soldier must be able to walk from 10 to 30 miles a day, day after day. In order to do this, his feet must be in perfect condition, and consequently Army and Navy medical officers have established certain rules to protect the health of their men's feet.

One of the most common foot diseases is athlete's foot or, as it is known to the medical profession, epidermophytosis or dermatophytosis. This disorder, which is exceptionally widespread, is usually transmitted in places where many persons walk unshod, such as floors in shower and locker rooms, swimming pools, bath houses, and so forth. If the condition is neglected, infection may appear, causing annoying pain and requiring several weeks to cure. Dr. Douglas G. Prehn, of the U. S. Navy Medical Corps, reported in the *Journal of the American Medical Association* (August, 1938) that in a survey of 1500 men on 11 ships, 92 percent were found to have the disease in its early or more severe stages.

Service medical officers, knowing that cleanliness and sanitation are requisites to the health and morale of a first-class soldier or sailor, have stipulated that our various services be provided with such equipment as delousers, clothing cleaning units, portable showers, etc. To prevent athlete's foot, medical authorities specify the use of foot tubs containing fungicidal solutions in camp showers and bathrooms. When a soldier's feet are immersed in a tub containing these solutions, fungi on the skin are killed and the feet are immune from fungus infection.

Development

The problem of supplying the Army with foot tubs was assigned to the Quartermaster Corps. Under usual conditions, this assignment would have been a simple one, as rubber foot tubs have been used for this purpose for years. The use of scarce rubber, however, was prohibited, and metal tubs will not withstand the various solutions used to combat this disease. After considerable research and exhaustive tests, it was found that a cellulose acetate butyrate plastic was a practical material from which to fabricate the tubs.

The next step was to design a tub which could be practically molded and which would withstand the physical conditions to which it would be subjected. As one of these tubs has to serve a number of soldiers, it had to be tough enough to take plenty of abuse but at the same time be so designed that its price would be economical. To overcome these problems, Quartermaster research engineers called in plastics engineers from material and molding companies and requested that they work with them in developing a plastic foot tub. The consensus of opinion as a result of these meetings was that an oval tub 22 in. × 16 in. × 6 in. would be a practical size. Wall thickness of the sides was specified as $^{1}/_{8}$ in. and of the bottom as $^{3}/_{16}$ inch. The tub was designed with ribs around the flange to maintain uniform sections and to increase the strength at this point. Sufficient draft was allowed on the sides to ensure quick ejection from the mold (see Fig. 1).

* Sales manager, Eclipse Plastic Industries.

PHOTO, COURTESY ECLIPSE PLASTIC INDUSTRIES

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Specifications

After fully considering all the problems involved in the production and use of a plastic foot tub, tentative specifications for it were drafted by the Engineering Department of the Quartermaster Depot. These specifications covered two types and sizes of foot tub—a new oval shape and the old rectangular form. The rectangular form was included so that molds formerly used for the manufacture of rubber foot tubs could be utilized if practical. One of the oval tubs which was specifically designed for plastics and which is discussed in detail in this article is shown in Fig. 2.

The material specified for the foot tub was cellulose acetate butyrate plastic with suitable plasticizer, free of coarse granular particles and capable of withstanding the action of each of the following solutions under normal usage:

3 percent solution of calcium hypochlorite
3 percent solution of sodium
10 percent hydrochloric acid solution
20 percent solution of sodium thiosulfate

The color was specified to be black or any other dark, solid, non-variegated color, and the surface of the tub was required to have a high luster or a smooth satin finish obtained by buffing or otherwise. The weight of these tubs was specified as 3 lb. 2 oz. with a plus or minus tolerance of 4 oz., up to 4 lb. 4 oz. with a 6-oz. plus or minus tolerance.

The tests to be made on specimen tubs taken at random from each shipment were quite severe. The fact that these tests were passed with room to spare will probably reveal new uses for thermoplastic parts of this size which were formerly put aside as impossible or impractical. Following is a brief summary of the test procedures and tests made on these plastic foot tubs:

Tests

Tensile strength test—Flat test specimens cut from the sides or bottom of the finished tub shall have an ultimate tensile strength of 3000 lb. to 4000 p.s.i. The elongation at ultimate strength shall be from 45 to 53 percent. The specimens shall be tested at 70° to 80° F. and approximately 65 percent relative humidity. The specimen shall be conditioned at this temperature and humidity at least 3 hr. prior to testing.

Test specimens shall be dumbbell-shaped, measuring approximately 4 in. long by $^1/_2$ in. wide. Edges of the test specimens shall not be cracked or chipped and shall be finished smooth with No. 000 (*Please turn to page 140*)

1—The plastic foot tub is removed from the semi-positive, semi-automatic compression mold, which is heated and cooled by alternate circulation of steam and cold water through channels cored directly into the mold. 2—Oval foot tub molded of tough cellulose acetate butyrate is resistant to chemicals, and won't warp, bulge or otherwise deform under hard usage. 3—Section of cavity for foot tub shows the large number of cores needed to heat and chill the mold to make possible the comparatively rapid cycle at which it is being run

COURTESY ECLIPSE PLASTIC INDUSTRIES

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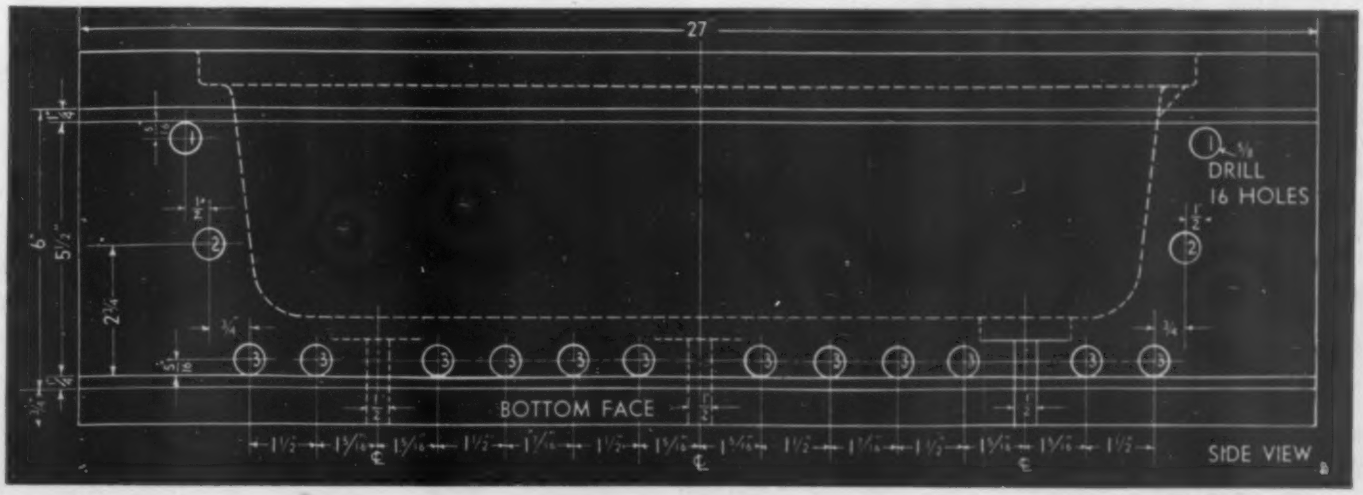

PHOTOS, COURTESY HEATH CO.

1—Light, inexpensive floats now used on military planes will be available for civilians after the war. 2—The float's top skin is a single piece of plastic-bonded plywood, glued to the skeleton in a specially designed jig. No nails are used

Seaplane floats go to war

THE Army Air Forces have sent the latest seaplane equipment—plastic-bonded plywood floats—to war. For the past year, numerous departments of the Air Forces have been endeavoring to secure small, light planes, equipped with float gear, for liaison and observation work in the various theatres of operation. However, due to the critical metal shortage, it was not possible to divert for floats the type of material customarily used for such equipment.

For over a year prior to Pearl Harbor, the engineering department of the Heath Co., manufacturers of aircraft components, had been developing plastic-bonded plywood floats for the light plane field. The high cost of the metal type of float and the popular demand for float-equipped planes led the company to investigate the use of this equally light but less expensive material. After extensive experiments, these floats were perfected, and the Civil Aeronautics Administration tests were passed with flying colors. The aviation industry had another new product, designed for practical and economical use by the private pilots of the nation. Along came Pearl Harbor and the activities of the private pilot and small operator were so severely curtailed that it looked for a time as if this new product would have to be shelved until after the war. On the contrary, however, a tremendous military need for these floats has developed.

The company's engineers designed a semi-monocoque type of float, with the plastic-bonded skin taking part of the weight load. It was amazing to see 6385 lb. of lead weights piled high on a float that weighed less than 70 pounds. In forming the structure, very few brads or nails were used. Stringers and gussets were held in place with speed clamps which were removed after a short drying period.

In applying the top skin—a single piece of plastic-bonded plywood over 14 ft. long and 40 in. wide—a special type of jig was used. A large steel frame was built and a heavy steel trough having the same curvature as that of the top of the float was fastened into it. After the top skin was placed in the jig, the skeleton with the glue already applied to the outer framework was set into the skin. A truss was then placed on this assembly and hydraulic jacks put into operation. After 4 hr. in this jig under 800 lb. pressure, the float was removed, the skin permanently fastened to the skeleton without the use of a single nail. This method of assembly serves two purposes: it avoids the wind resistance caused by outer obstructions such as heads of nails, and it presents no problem of nails corroding out, due to the action of salt water. The bottoms of the floats are set in place with nailing strips which are removed after the glue is dry, and the few holes so created are filled in.

The use of plastic-bonded plywood gave the float a larger displacement but less weight than the metal type, which made it more practical from a military standpoint. Since it is common practice to carry a great deal of essential equipment on these planes, they are often overloaded. The extra buoyancy given by the plywood floats permitted planes to carry extra weight without suffering tardy take-offs, and also made them safer while taxiing in the water. With four watertight bulkheads in each float, a plane can remain on the water with two of them damaged in each.

Many questions as to the sturdiness of the plywood float as compared to the metal types were answered when the company test pilot flew a plane off a snow-covered airport and gave many demonstrations of take-offs and landings without damage to the floats. Another matter that merits consideration is the ease with which floats can be repaired. Should one become damaged when the plane is away from its base, the pilot can put some aircraft dope on the damaged part, tear up a handkerchief and place over it, apply another coat of dope over the cloth, and wait only 30 minutes before taking off again. Permanent repair of such damage is a simple matter, too. It is necessary only to cut out the damaged section, bevel the edges, insert a piece of plywood well daubed with glue, and let it set for 4 hours. The patch will make the float as good as new.

Credits—Material: Plaskon urea-formaldehyde resin glue.

Unlimited revolutions for gun turrets

WHEN American bombers first appeared in the European war theatre, the young Supermen of the *Luftwaffe* brashly took after them in their Messerschmitts and Heinkels, anticipating a lively killing. The big fellows, flying in majestic formation, did indeed look like easy targets—and on their way down, the Nazi masterminds had scarcely enough time to figure out just what had gone wrong!

Responsible for the abrupt demise of many a promising Goering disciple who so summarily attacked the newcomers was his unhappy underestimate of their defensive armament. Well able to look after themselves are U. S. bombers, many of them protected by power-operated revolving gun turrets. Gunners in these turrets, either perched atop the fuselage or hanging beneath it, can in an instant swing into covering positions and direct at their attackers a continuous burst of fire from their heavy-calibre machine guns.

In designing revolving turrets one of the major problems was that of connecting them to several electrical power, radio and telephone circuits and providing them with an unfailing supply of oxygen. If we had followed the German approach to this problem, we should have had a very simple device, for it is an established fact that the German 88 mm. mobile artillery has power transmitted to its revolving gun turret by a slack length of multi-circuit cable which carries power, radio and telephone circuits. This method, however, has one dangerous drawback which has lately proved disadvantageous in the African theatre of war. According to reports, the revolving platforms on which these guns are mounted can make approximately $1^1/_2$ turns, after which they must "unwind" because the power cable becomes tight and prevents the turret from revolving past this fixed limit.

Imagine, if you will, a machine gunner in one of our Flying Fortresses whose turret has been equipped with power transmission cables similar to the German 88-mm. installation. Several enemy planes attack. He has manipulated the turret in one direction until it has reached its turning limit. Then an enemy fighter maneuvers just out of the area which the gunner can cover with his guns in this position. These guns, therefore, cannot be brought to bear on their target until he revolves his turret in the opposite direction through nearly a full turn. It is very easy to see why the turrets on American planes were designed to perform unlimited revolutions.

The power transmission unit which makes continuous revolving possible has fundamentally two major parts: a stator (shown assembled in Fig. 1, left) which is permanently fastened to the main body of the plane, and a rotor (Fig. 2)

1—Because of the heavy wall sections and numerous deep draw sections, transfer molding was used for the phenolic stator shown assembled at left. This part of the power transmission unit is fastened permanently to the main body of the plane

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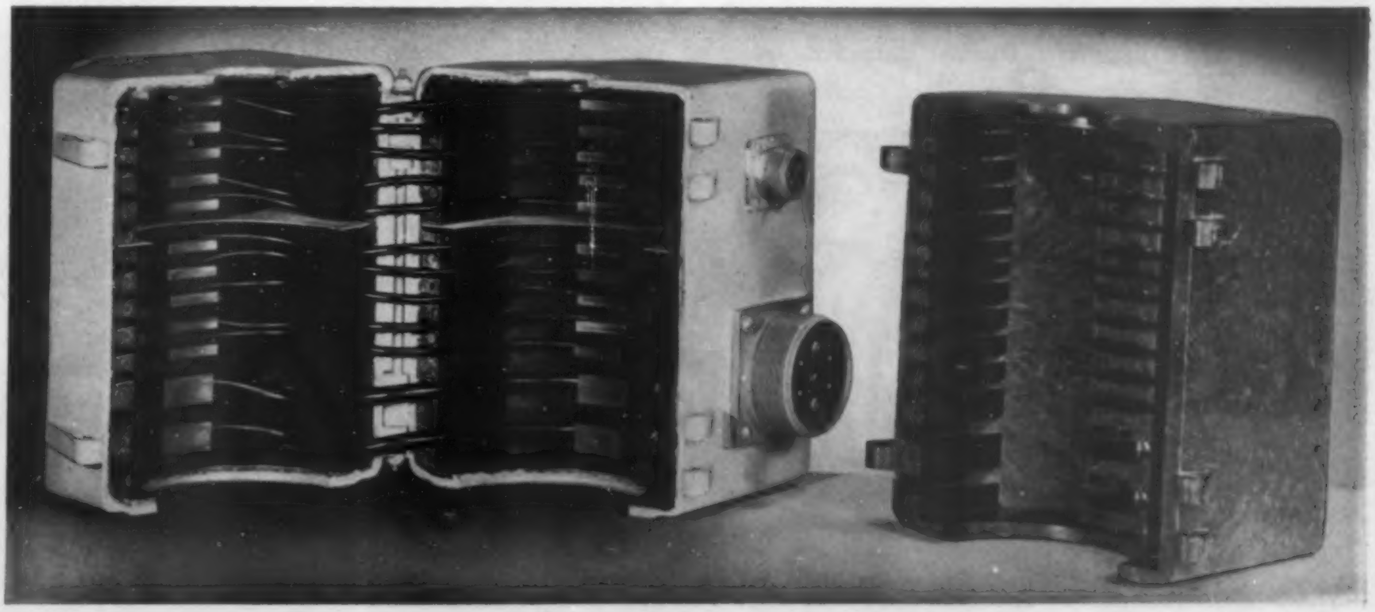

which is permanently attached to the rotating turret. The various electrical circuits which are stationary in the main body of the plane are connected to the stator by means of standard Cannon connector plugs. Each circuit from the male portion of these plugs is permanently wired to the brush assembly, which is clearly seen in the assembled unit (Fig. 1).

Two views of the rotor are pictured in Figs. 2 and 3. Cutaway section at the right of the assembled unit shows the metal slip rings which are molded as an integral part of the unit. This assembled rotor is made up of two parts which butt together, one part containing 5 slip rings, each connected electrically to binding posts as shown in Fig. 3. A second part makes use of 7 slip rings, each connected electrically to pins forming the male portion of a special Cannon connector plug. The section of the rotor containing the 7 slip rings is the power side and the section containing the 5 rings is the radio and telephone side.

The two rotor units are assembled together by means of a threaded metal pipe which screws into the threaded insert which can be seen in the cutaway section of the rotor. Before assembling these rotor sections, a thin metal disk is placed between the two halves. A hole through this disk permits passage of the pipe. After the pipe is tightly screwed in place, the metal disk, grounded through the pipe, makes up one section of the shielding which protects the radio and telephone circuits from any interference or static which might be set up from the power circuits.

Molding the units

The accuracy which was necessary in molding these two rotor units, plus the fact that the connections between each slip ring and its binding post or pin terminal were molded-in, made this job one of great difficulty. Due to the weakness of the connections between the slip rings and the pin terminals and binding posts, it was practically impossible to make use of compression molding; and even with the much easier flow characteristics made possible by transfer molding, the problem of holding these weak wires accurately in place was very great. The mold for the large rotor consists of a chase containing a pair of splits and top and bottom plates which form the ends of the rotor and carry the core piece. This mold is used in a 100-ton flatbed press with a separate transfer pot and plunger. An injection pressure of approximately 7000 p.s.i. is exerted on the medium impact phenolic material, and with this pressure the mold cavity is easily filled. A production rate of approximately 25 to 30 pieces per 8-hr. shift is normally a long molding cycle. However, a relatively small percentage of this time is taken in the press, the greater part of it being "bench time" needed for installing the inserts and stripping the part from the mold.

The small rotor is molded in the same manner and in the same type of press, but due to the simpler construction and smaller number of inserts, the production is approximately 35 pieces per 8-hr. shift.

Although these pieces are extremely complicated there are very few finishing operations, as the parts merely require flash removal, buffing and the drilling and tapping of one or two holes. It is necessary, however, to silver plate the slip rings after molding.

Because the case or stator portion of this unit (Fig. 1) has very heavy wall sections and numerous deep draw sections, it was decided to transfer mold this part as well. The two halves of the case are identical except that inserts are molded in one half and omitted in the other, which makes possible the production of both halves from a single-cavity mold. It is true that the bare insert pins mold 10 small holes in the half which has no inserts, but these holes are not objectionable in any way. Mold equipment consists of a single-cavity die which is designed to operate semi-automatically in an angle press. The mold is held shut by the side ram, which exerts a pressure of 225 tons, and the material is injected by means of a 75-ton vertical ram. The advantage of this type of set-up is that the area of the pressure pot does not have to be larger than the total projected area of the molded piece. Whenever parts with large projected areas are transfer molded in a flatbed type of press, the clamping pressure between the mold halves is gained through the differential in area between the pot and the molded part. It can be easily seen, therefore, that single ram flatbed transfer molding has definite limitations which can be overcome only by having a separate ram for clamping. Approximately 40 heats per 8-hr. shift are produced from this molding set-up, which is approximately twice the production that would be possible by compression molding—that is, if the material tests with comparable acetone extractables.

Finishing operations

Several finishing operations are necessary to complete the two halves of this case. Holes must be drilled through the hinge lugs, and one half of the case requires two large holes to accommodate the male portions of the Cannon plugs. A groove is machined completely around the rim of both case sections, its purpose being to provide an undercut lock for a metal plating job. The entire outside surface of the cases is

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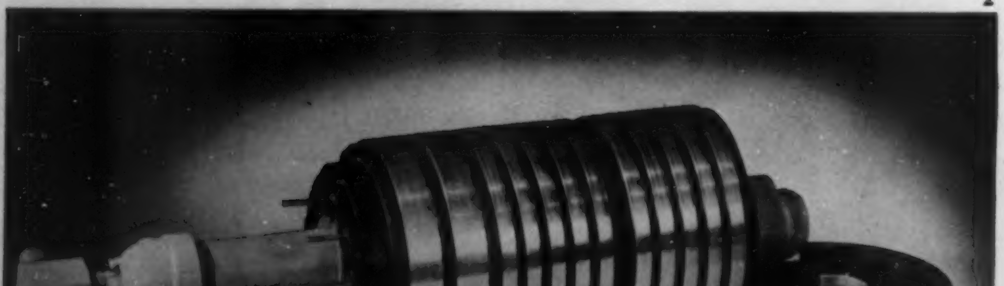

2—The assembled rotor consists of two transfer molded parts butting together, one containing 5 slip rings, the other 7 slip rings. The cutaway section at right shows a section of these metal rings which are molded as an integral part of the unit

metal plated. In Fig. 4, which pictures the interior of the unit, the difference in color between the plated surface and the plastic along the upper rim of the case clearly shows where the plating stops. It is along this line of demarcation that the plating locks into the machined groove. If these cases had been completely plated both inside and out there would have been no possibility that the plating might strip, but the insulating qualities of the phenolic material were necessary on the inside. Normal metal plating of phenolic surfaces has an adhesion of approximately 500 p.s.i. under direct tension. However, when the plating terminates in a sharp edge with no added grip, it is quite fragile and may start to peel away from the molded surface.

After the plating operation, the two case halves are assembled by means of a metal hinge pin. The brush assembly and the two male halves of standard Cannon multiple-type pin connector plugs are assembled and wired to the terminal inserts which have been molded into place, with the exception of two high power leads which are carried directly from the brushes to the connector plug and soldered in place. Two half-moon sections of thin metal shielding are inserted in the molded groove in the case where they separate the 5 telephone and radio circuits from the 7 power circuits. Figure 1 shows the case at this stage of its assembly.

Figure 4 shows the slot between the two rotor sections which accommodates the two half-moon metal shielding parts. These shields are grounded to the outside plating by means of a self-tapping screw which is screwed into the case from the outside and jams against and along the edge of the shielding plates on the inside. This problem of shielding the telephone and radio circuits from the power circuits was one of paramount importance and the neatness with which this has been accomplished shows the engineering ability and vivid imagination of the designer.

A special 90° street L is assembled on the pipe which assembles the two halves of the rotor. A hole on the top of this L is then used to accommodate the stationary end of a gas tight swivel joint which is held in place with a small U-shaped locking lug fastened to the L. The swivel end of this gas tight joint, which is on the right of the housing in Fig. 4, has a machined groove which nests into cutaway sections of the case. The molded surface at the outer end of the large rotor half-rested in a cutaway section of the case (at the left in the photograph) acts as a bearing surface, permitting the entire rotor section to turn in the stator, or case.

Figure 5 shows the unit completely assembled and ready to be mounted in the plane. The small pipe at the right delivers the oxygen, and the street L and large pipe at the left act as the shielded conduit for the 5 telephone and radio circuits. The connections from the 7 power circuits on the rotor are picked up by the special Cannon pin type plug.

It is not often that a custom molder will undertake so complicated a job as this one appears to be. While the molding problems are, of course, difficult, the actual molding is a small part of the completed job. This molder has taken on all the headaches inherent in so complicated an assembly and has come through with flying colors, thereby permitting the machine gun turrets in our bombers to rotate without fear of reaching the limit. It is by such ingenuity in design and production that the United Nations give their fighting men the best that can be had in fighting equipment.

Credits—Material: Bakelite, molded by Plastic Manufacturers, Inc., for Glenn L. Martin Co. Designer: George W. De Bell in cooperation with Glenn L. Martin engineers. Case plated by Metaplast Corp.

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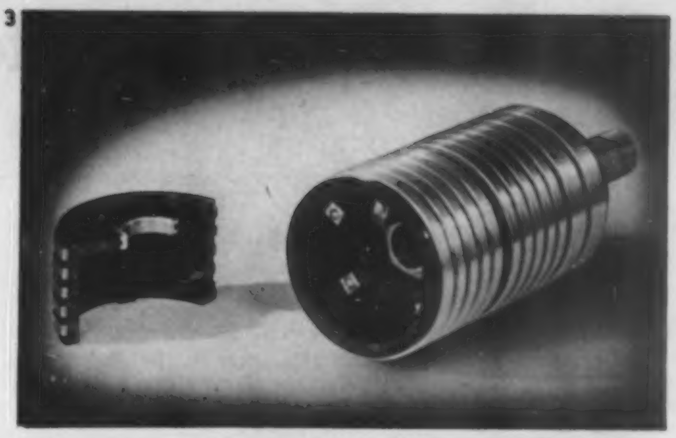

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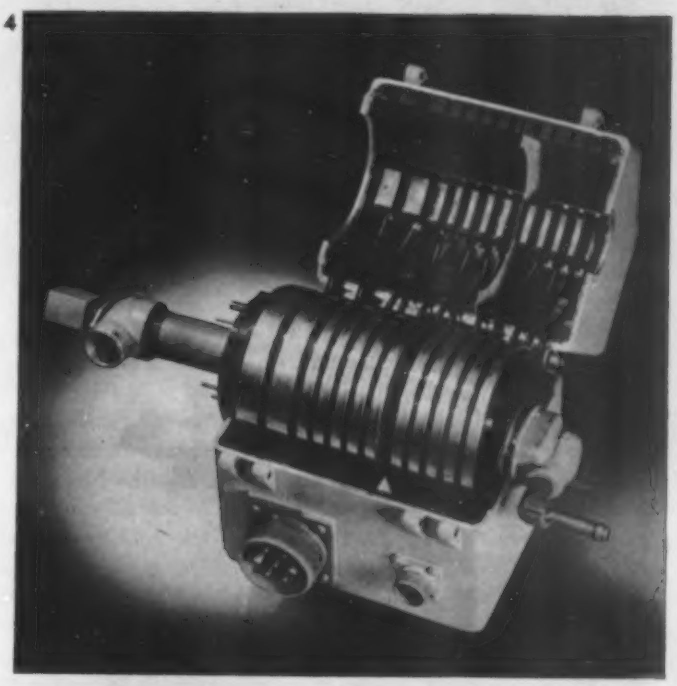

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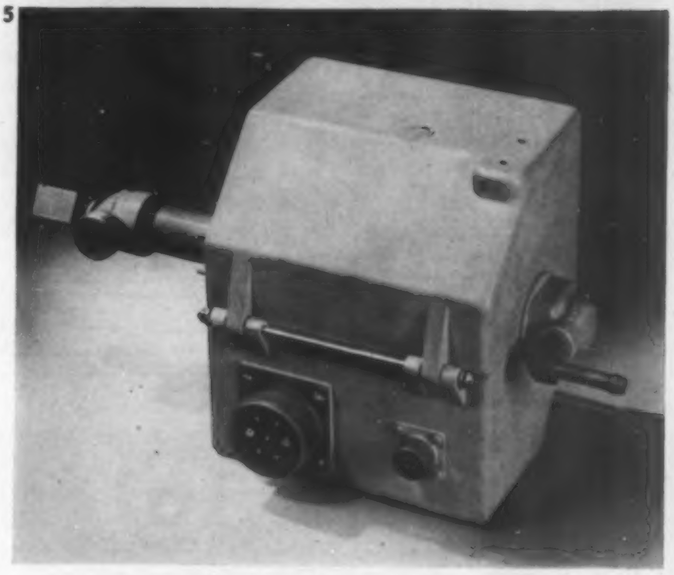


3—In this end view of the assembled rotor, 5 slip rings are shown connected electrically to binding posts. 4—At the right of the power transmission housing is the swivel end of the gas tight joint having a machined groove which nests into cutaway sections of case. 5—The small pipe at right delivers the oxygen; the large pipe at left acts as a conduit for telephone and radio circuits

Hydraulics in transfer molding

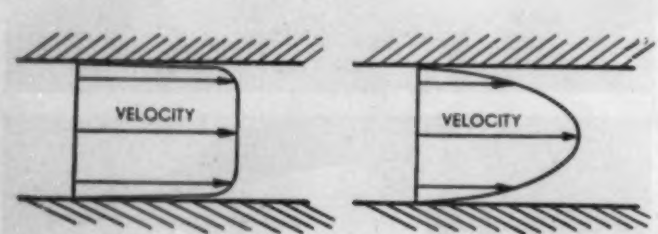
by GEORGE W. De BELL*

IN transfer molding most molders think of hydraulic flow merely as a means of moving the molding material from the pot into the cavity. They seldom consider that the method of transferring the material from the pot to the cavity may have an appreciable bearing on the strength of the ultimate product or that the material may be degraded in quality during the transfer.

Let us for a moment consider the fundamentals of the theory of hydraulic flow. Basically, the flow may be "laminar" or "turbulent." In laminar flow, the molecular layers of the fluid are considered to slide over one another without disturbing their respective laminar boundaries. Laminar flow might be visualized as the sliding on each other of the individual sheets in a pad or paper when the pad is flexed. Turbulent flow, as the term implies, infers rapid agitation and co-mixing of the various molecular boundaries to such an extent that there is no smooth sliding of one layer on the other.

An example of the two types of flow which is familiar to everyone is that of the common canoe paddle. If the paddle is moved edgewise, the water separates and comes together again without visible disturbance of the surface or of any particles which may be floating on it. This is an example of laminar flow. If, however, the paddle is moved rapidly broadside, a violent swirl is set up behind each edge of the paddle. This is a good example of true turbulent flow. Following this analogy, one can readily realize that much more power is consumed if the flow is turbulent rather than laminar. This is to be expected, as much higher local velocities are set up in the fluid and, of course, the additional power necessary to produce these velocities must be contributed by the one wielding the paddle.

* Consulting engineer.



(A) LOW VISCOSITY

(B) HIGH VISCOSITY

FIG. 1

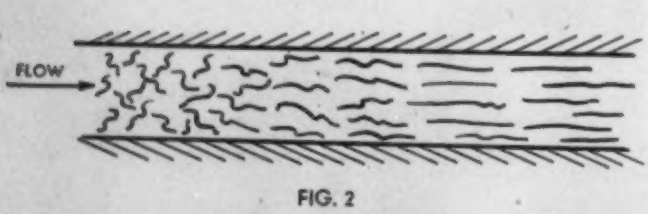
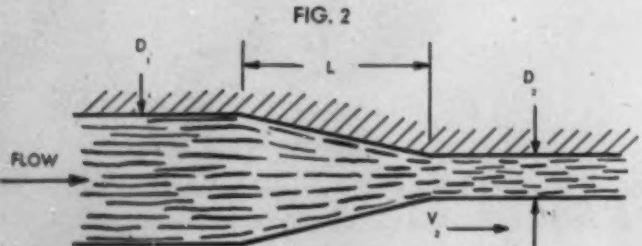


FIG. 2



$$V_2 = V_1 \left(\frac{D_1}{D_2}\right)^2$$

FIG. 3

Normally, when the word "hydraulics" is used, the average person thinks in terms of water, but the theories of hydraulics are applicable not only to water but to any other fluid. When considering the application of hydraulic principles to the flow of fluids, one of the essential properties which must be taken into account is the viscosity. Water flows readily and has a low viscosity whereas other materials, such as very heavy oils and a majority of the plastics, have a high viscosity. If fluids of different viscosity are made to flow in identical pipes or channels the velocity distribution across the channels will be noticeably different. Figure 1 (A) illustrates the type of velocity distribution which might be expected in a fluid of low viscosity, while Fig. 1 (B) illustrates the velocity distribution which might be expected in a fluid of high viscosity. An inspection of these figures will show that while in both cases the velocity is zero at the walls of the channel, it approaches its maximum value much more rapidly in the case of low viscosity fluids than in the case of fluids with high viscosity. In other words, at a short distance from the walls of the channel the velocity is substantially the maximum in the case of low viscosity fluids, while it is much less than maximum in the case of high viscosity fluids.

Investigation of the hydraulic formulas for turbulence will indicate that it is much more difficult to set up turbulence in fluids having high viscosities than in those having low viscosities. This is due to the high damping factor attendant on high viscosity; and since most plastics are of the high viscosity type, turbulence will probably not occur unless the injection velocity is very high or the channel of such a shape that it will readily induce turbulence.

All the impact type transfer molding materials are of the high viscosity type whether filled with flock or macerated fabric, and therefore the velocity distribution in the sprues and runners is similar to that shown in Fig. 1(B). Although the fiber lengths or particle sizes of the filler vary appreciably in commercially available materials, we may, without invalidating the theory, consider a plastic filled with individual fibers of constant length. If such a material with the fibers heterogeneously distributed is made to flow through a straight channel, the tendency of the previously mentioned velocity gradient will be to straighten out or orient the fibers so that they are all substantially parallel with the direction of flow. This action is illustrated in Fig. 2. At the left hand, or entry side of the figure, the fibers are unoriented, while at the right hand they have become aligned with the channel.

For further clarification of this action let us consider a fiber which is aligned substantially crosswise of the channel with one end on the centerline of the channel and the other adjacent to the wall. Because of the velocity gradient, the end nearer the center will be moving at a faster rate of speed

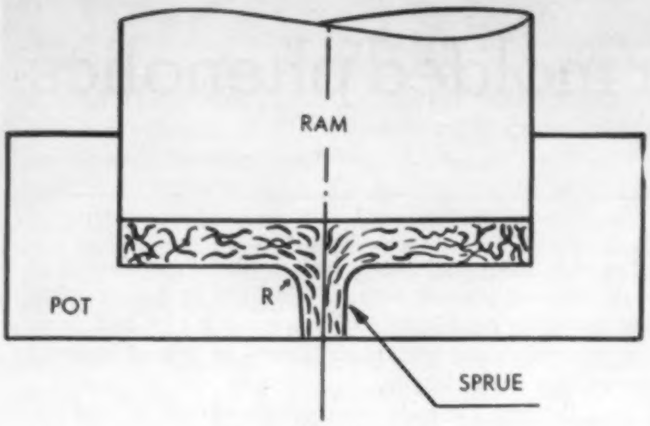


FIG. 4

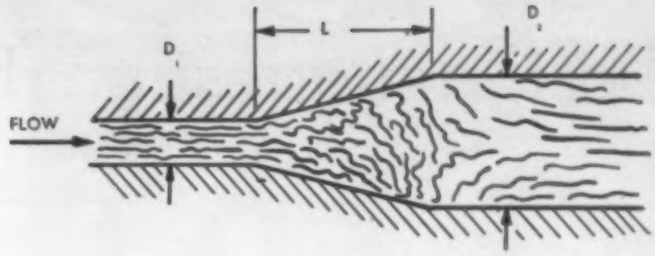


FIG. 5

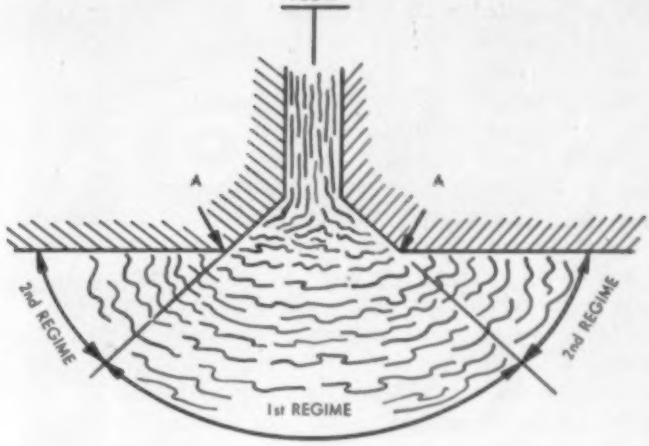


FIG. 6

than the end nearer the wall, and therefore there will be a tendency to straighten out the fiber and make it parallel with the axis of the channel. The forces acting on the fiber to produce this effect are transmitted to it through the viscous adhesion of the fluid, and the rapidity with which the fiber orients itself varies as the viscous adhesion varies. In other words, the oreintation will be much more rapid in a fluid having a high viscous adhesion.

Let us now consider what effect varying the size of the channel will have on the fibers. In Fig. 3 we have reduced the size of the channel from a diameter D_1 to a much smaller diameter D_2 in a length L. Since the fluid is substantially uncompressible, and since the same quantity must be flowing in all sections of the channel, the velocity of the fluid in the small diameter D_2 will be much higher than in the larger diameter D_1. If we use the symbol V_1 for the velocity in the larger diameter and V_2 for the velocity in the smaller diameter, we arrive at the following relationship:

$$V_2 = V_1 \left(\frac{D_1}{D_2}\right)^2.$$

In other words, the velocity varies inversely as the square of the diameter. It will be noticed in Fig. 3 that the fibers are much longer in the D_1 portion than in the D_2 portion. This is due to the rapid change in velocity tending to tear the fibers apart and thereby reduce them in length.

To illustrate this action, let us now consider a single long fiber as it enters the tapered portion L. As the front end of the fiber enters the tapered portion, the increased velocity tends to exert a force on it through the viscous adhesion; and if the viscous adhesion is sufficiently high, then the forces will be of sufficient magnitude to overcome the tensile strength of the fiber and break it. Since in a given fluid the force exerted through the viscous adhesion is proportional to the rate of change of velocity and to length and diameter of the fiber, it can readily be appreciated that there is a far greater tendency to break long fibers than to break short ones, and a relatively abrupt increase in velocity is much more damaging to fiber length than a gradual one. In other words, if the distance L is long the force probably will not be of sufficient magnitude to rupture the fibers, while if the distance L is relatively short then the probability of fiber breakage is increased.

Let us consider the pot and sprue as normally used in transfer molding. A cross section of such a typical pot is shown in Fig. 4. As the ram compresses the material, flow begins. The material adjacent to the sides of the pot must move inward and discharge through the sprue; and as the material approaches the sprue location it can readily be appreciated that its velocity materially increases. As it enters the sprue, a still further increase occurs because of the difference in the net areas of flow. The effect of this rapid increase in velocity is to reduce the particle size or fiber length of the material as has been illustrated in Fig. 4. If the radius R of Fig. 4 is small, then the rate of change of velocity will be large and the damage to the material relatively great; and conversely if R is large, the velocity gradient (and therefore the damage) will be lessened.

The effect of flow of material from the sides of the pot should not, however, be overlooked. As the material must all move to the center in order to get out the sprue, and as the flow area becomes progressively smaller as the center is approached, there is a tendency to produce a velocity gradient across the bottom of the pot. If the pot is large in diameter in comparison with the diameter of the sprue, then there will be greater danger of shredding the filler stock as it moves toward the sprue. In most designs of transfer molding dies the pot area must be larger than the parting line area of the product, and therefore it is not always possible to use a pot of small diameter in comparison to sprue size. But damage to the filler material can be minimized by being careful that the ram is not closed too rapidly, as the velocity gradient in the material is proportional to the rate of closing of the ram.

Let us now consider the effect of expanding the size of the channel, as in Fig. 5. In this case, the velocity of the material reduces as the channel expands; and therefore instead of the fibers stretching out they tend to collapse or accordion, and rotate to a position approximately perpendicular to the axis of the channel. Again let us consider a single fiber moving from left to right through the channel as depicted in Fig. 5. In the straight portion D_1 the fiber is straight and parallel to the channel, but as the end of the fiber enters the tapered portion L it slows down because of the lower velocity, and the rear end (*Please turn to page 148*)

Design suggestions for molded phenolics

by MARK MAXWELL*

MOLDED phenolics, a type of thermosetting plastic, are manufactured from fabric, paper, or woodflour filler, impregnated with a synthetic phenol-formaldehyde resin and compressed under heat to form an insoluble, infusable molded shape.

Used for complicated shapes, large production quantities of either simple or complicated shapes, or for certain properties obtainable only in form molding, molded phenolics are now proving their worth in essential and diverse applications. Typical of present-day uses that require light weight, strength and stability of dimensions are: in aircraft, as control pulleys, bomb racks, and antennae masts; in seagoing craft, as large propeller shaft bearings and switchboard panels; and in factory crafts as roll neck bearings for the steel industry, suction box covers for the paper industry, spinning buckets for the textile industry, chemical tubing for the processing industries, and gears, pump valves and piston rings for every industry.

Phenolics are generally divided into two groups, laminated and molded. This article will be confined to a discussion of the latter. Three phases will be discussed: 1) what molded phenolics are, 2) when they are used and 3) how they are used.

Composition and forms of molded phenolics

The molded phenolic is made up chiefly of two general constituents, the filler and the resin. Additional ingredients are pigments, plasticizers and catalysts.

The *filler* may be chosen from 5 different materials, namely, cotton fabric, glass fabric, rag or wood fiber paper, asbestos paper, or woodflour. After selection, the filler is saturated with a resin.

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The *resin* used may be made by a synthetic combination of many different phenols with an aldehyde or ketone. The most favorable combination of properties is obtained, however, in a resin made when phenol, cresol or xylenol is caused to react with formaldehyde.

The filler and the resin are carefully chosen for the mechanical, electrical and chemical properties it is desired to impart to the molded piece. The four forms of molded phenolics, separated in accordance with the state of filler used, are: 1) powdered, 2) laminated, 3) chopped or macerated and 4) a combination of laminated and macerated.

The *powdered form* is composed of a mixture of powdered resin with woodflour or asbestos fiber. An advantage of this form is that the particles are finely divided and the molded pieces are small. Therefore cure time is rapid and production turnover fast. Disadvantageous, however, is the comparatively low mechanical strength which is caused by the lack of filler continuity.

The *laminated form* is made of layers of resin-impregnated cloth or paper. Laminate molding is similar to straight laminating except that in the former the layers are cut to fit the contour of the mold. The advantage of filler continuity gives to this form high impact toughness and desirable mechanical strength, superior to powder molded forms. Its disadvantage, except when fast cure resins and thin sections are used, is that laminate molding requires a longer time cycle per piece—a cycle sufficiently long to cure and also to cool the thicker sections for the prevention of blisters or air pockets.

The *macerated form* is composed of resin-impregnated cloth or paper chopped into small squares from $^1/_8$ in. to $^1/_2$ in. in dimension. When it is found impractical to cut layers of material to fit the contour of the mold, macerate molding may

1—*Curve shows thermal effects on impact on a chopped heavy weave fabric molded phenolic.* **2**—*Stress-strain diagram of a representative grade*

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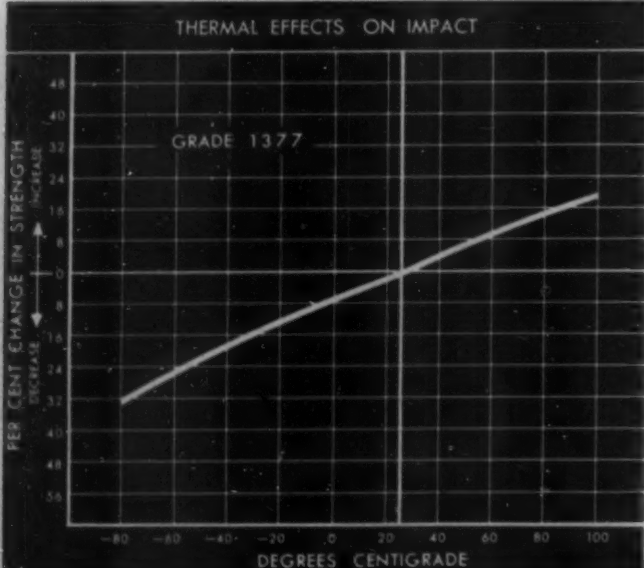

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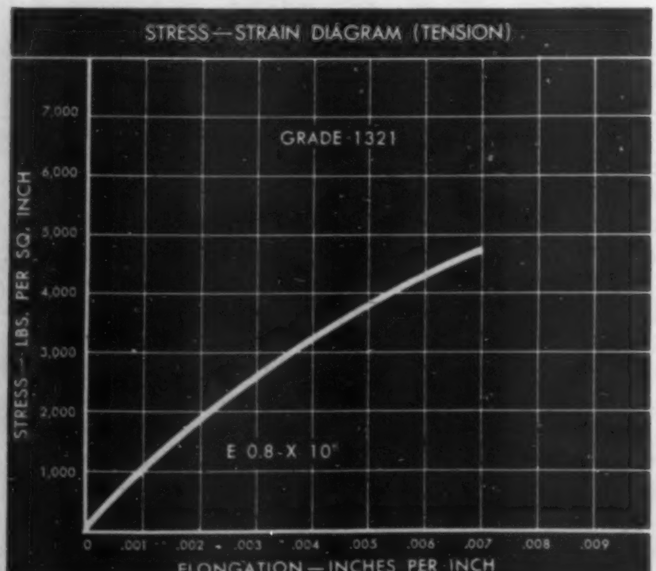

offer the solution. When chopped material is compressed under heat in a mold of required design, the molded piece assumes its contours. Macerate molding does not own the inherent continuity of filler possessed by laminate molding, and so exhibits lower mechanical strength. On the other hand, more uniform strength characteristics are offered by the products of this form, and maximum directional strength may be obtained where needed. In common with laminate molding, macerate molding does not usually lend itself to rapid cure and cool molding cycles.

The *combination form* is used where macerated material requires reinforcement. Then the incorporation of laminate sheets is found to add valuable strength. A suitable balance must be maintained because, although mechanical strength increases with larger particle size, intricacy of design is sacrificed. Similar considerations as to molding cycle apply to the combination as well as to laminate or macerate forms.

When molded phenolics are used

The decision to apply molded phenolics is made from two bases, the general and the specific. The basis is general when both laminated and molded phenolics may be applied and depends on their common physical and chemical properties. The specific basis covers applications for which molded phenolics are preferred to laminated.

In general, either laminate or molded phenolic may be used at the following times:

1) When electrical insulation is required, since they exhibit very high dielectric strength.

2) When moisture and chemical resistivity is sought, because they neither warp nor swell when covered by water, and they are not materially affected by weak acids, alkalis or organic solvents.

3) When exposed to various conditions of heat and cold, because these thermosetting resins neither crack at −80° C. nor distort at +160° C. Tests show that tensile and compressive strengths increase below zero, while impact toughness increases at higher temperatures.

4) When operating noise is to be reduced and machine vibrations dampened, since they own a resilience which tends to absorb severe vibrations and to cushion repeated shocks.

5) Most important, when a combination of mechanical strength and light weight is sought, because they withstand high compression loads, pound for pound, better than steel; they flex well without fatigue failure, flexural strength being high and hysteresis low; and they resist hard impact blows. The average density is .05 lb. per cu. in., which indicates the lightness of material.

In general, then, both molded and laminate phenolics are used when certain of the foregoing properties are needed for an application. The next decision is specific: when to use phenolics of the molded rather than of the laminate class?

Laminate forms are made by heating compressed stacks of resin-treated material between flat plates or on round mandrels. Plates, angles, channels, rods, tubes and zees are produced which then must either be cut to a series of required lengths or, if a curved piece is desired, be machined to proper shape.

Molded forms, on the other hand, are molded directly to the desired shape by compressing the powdered or macerated

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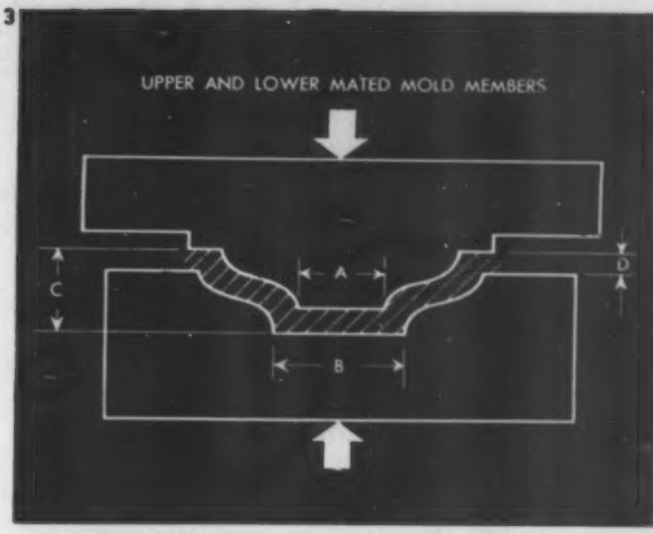

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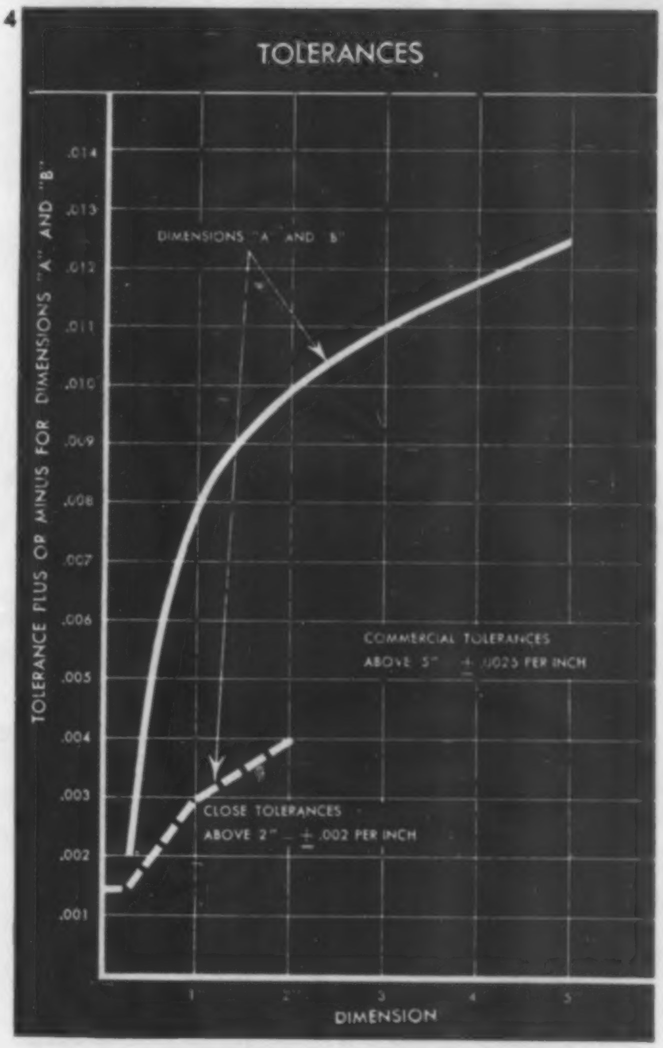

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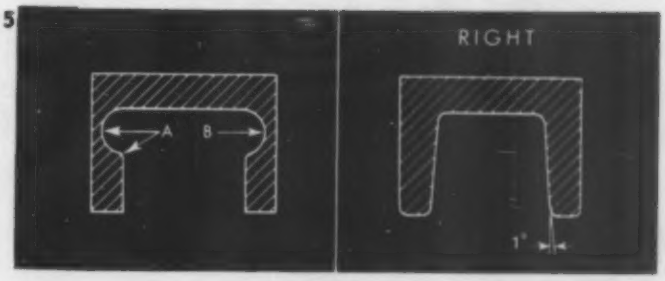

3—Dimensions and tolerances in flash type mold. 4—Curve shows variation of close and commercial tolerance with piece thickness. 5—Figure showing right and wrong design for undercuts and sidewall drafts in molded piece

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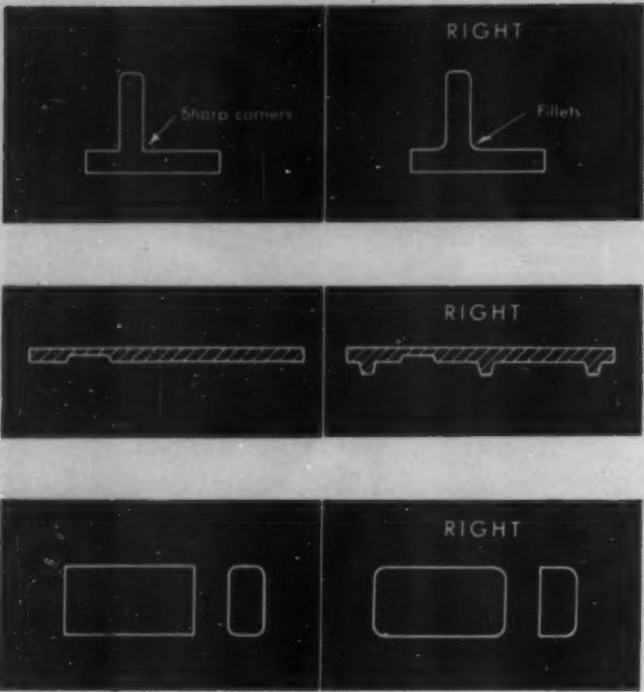

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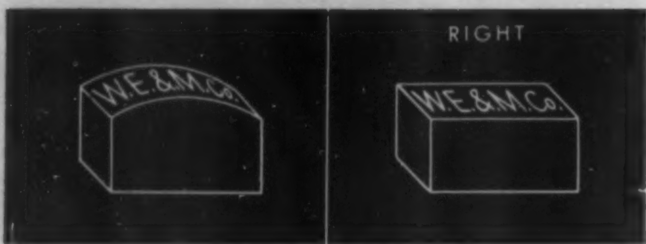

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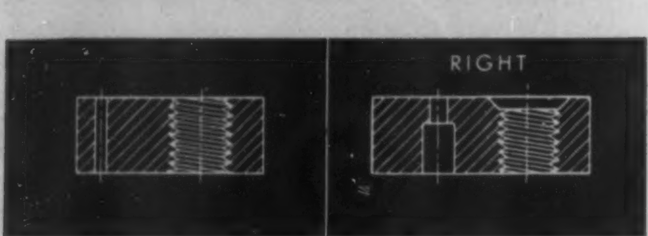

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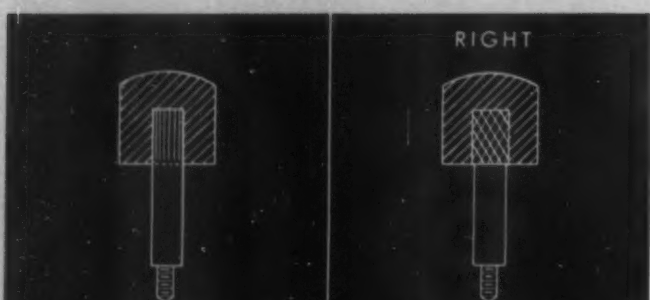

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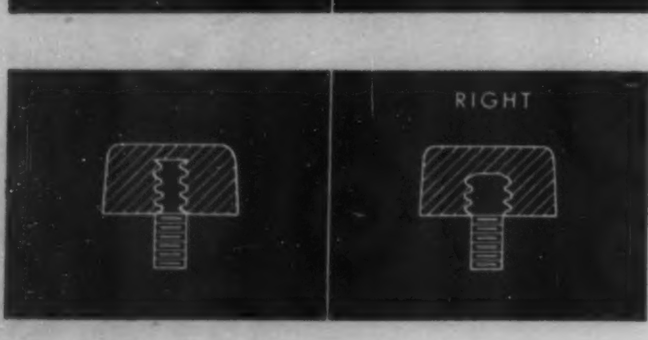

material in a heated mold designed to impart the proper shape to the finished piece. As a result, molded forms have three inherent advantages over laminated forms: 1) machining operations to fabricate each molded piece to required shape are not necessary, thus saving man-hours, money and material; 2) the surface of molded pieces is covered by the shiny, hard resin acting as a glossy and protective coating, while the machined surfaces of the laminate pieces do not possess this coating; and 3) maximum directional strength where needed may be more easily incorporated in the molded forms.

Therefore, when a specific decision between classes must be made, molded phenolics are chosen over laminated: 1) when large production quantities of simple or complex form are required, making it costly or impractical to machine each piece to shape; 2) when the glossy and protective coating of the molded piece is preferred to a dry machined surface; 3) when certain maximum directional strength is required.

How molded phenolics are used

As the first and most important step in the selection of the proper molded phenolic, the requirements of use should be thoroughly established. If the finished piece must be resistant to water or to chemical solvents and vapors, if it is to resist high impact loads or possess good mechanical strength, or if it must insulate heat and stop the flow of electricity, these qualifications must be settled in advance. After these application requirements are clearly and completely defined, the commercial grade listing is examined to match properties and requirements and to select the most suitable grade. Following this, considerations of designs are applied and the product is processed through the three stages of manufacture.

Six representative grades of molded phenolics are shown in

6—Three right and wrong designs for fillets, ribs and radii. 7—Right and wrong designs for raised letters. 8—Right and wrong design for holes and threads. 9—Inserts should be designed with a diamond knurl to prevent twisting or pulling out. 10—Inserts should not extend close to surface and should be designed to prevent flow of material into threads after molding. 11—Threaded inserts extending through or almost through piece should be avoided. 12—Avoid exterior diamond knurls. Straight knurls give neater appearance and are less expensive

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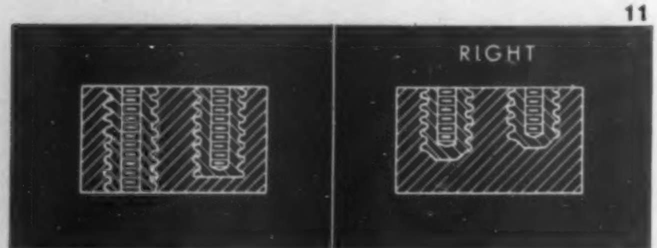

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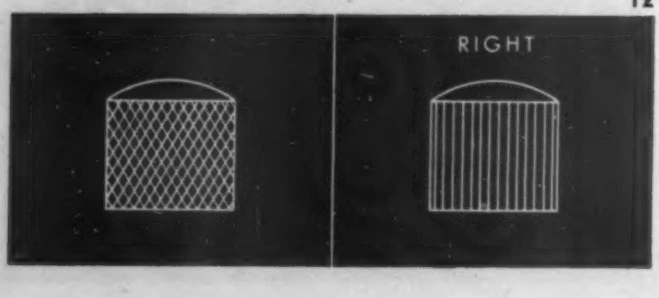


Table I.—Grade Selection and the Mechanical and Electrical Properties of Six Grades of Molded Phenolics

Application requirements	*Micarta Grade No.*	*Base material*	*Max. operating temp., ° C.*	*Moisture absorption*	*Tensile strength*	*Compressive strength, p.s.i.*	*Shear strength, p.s.i.*	*Flexural strength, p.s.i.*	*Impact strength, Charpy, ft.-lb. per in. notched*	*Dielectric strength, Short time test, $^1/_8$ in. thick, volts/mil.*	*Brinell hardness, 10 mm. ball and 5 kg. load*
Good compressive strength; fairly low moisture absorption; ordinary electrical characteristics; good impact strength *Examples:* aircraft control quadrants, terminal blocks, bell cranks	1321 (tan) 1345 (black)	Chopped heavy weave fabric	100	2.9	6,000	29,000	10,000	9,100	3.1	170	32–40
Best resistance to moisture; good compressive strength; best dielectric strength; intricate parts; low impact strength *Examples:* rayon spinning bucket liners, pneumatic pistons	1360 (tan)	Chopped fine weave fabric	100	0.8	5,800	30,000	7,500	9,800	1.2	400	32–40
Best physical properties; simple designs; good resistance to moisture *Examples:* aircraft pulleys	1377 (tan)	Chopped heavy weave fabric	100	2.3	7,200	30,000	9,700	10,200	2.9	185	32–40
Highest impact strength; good physisical properties *Examples:* clamps, housings	199 (black)	Shredded fabric	100	1.3	7,500	21,000	10,000	11,000	3.2	335	32–40
Best heat resistance; fair physical properties; low moisture absorption *Examples:* commutators, collector rings, line material, couplings	102 (brown)	Long asbestos	125	0.2	6,000	23,000	10,000	11,000	1.2	200	48
General-purpose material; best appearance; fair physical properties *Examples:* handles, knobs, cases	165 (black)	Woodflour	100	0.9	6,000	22,000	10,000	10,000	0.55	350	40

Table I with typical applications and properties of each grade listed. Curves illustrating physical properties of two representative grades are shown in Figs. 1 and 2. The commercial grade best suited for a particular application should be chosen from such curves and charts.

Design considerations

When the molded phenolic is to be newly applied or when it is to be substituted for a material previously used, careful and experienced designing is necessary to prepare successfully the projected application for production. This "know-how" designing is now common knowledge among plastic manufacturers. It has evolved through years of experience with design problems involving dimensions and tolerances; undercuts and sidewall drafts; fillets, webs and ribs; letters, holes and threads; inserts and assembly.

Dimensions and tolerances on molded pieces are interrelated since both are settled by the fixed mold dimensions and by the relative positions of the mold members. Using the example of a flash-type mold (Fig. 3) dimensions A and B of the part are fixed by the dimensions of the mold. Dimensions C and D, the flash thickness, are determined by the relative positions of the mating mold members.

Tolerances are of two kinds: close and commercial. The commercial tolerance is used when possible because of lower mold cost. Tolerances for dimensonis A and B are fixed by the mold. The curve in Fig. 4 shows how these dimensions vary with piece thickness. For the C and D dimensions, dependent on the relative positions of the mating mold members during molding, the following tolerances apply:

	Inches	
Readily molded short fiber materials, like woodflour, short asbestos, mica, cotton flock and cellulose	.008	.005
Longer fiber materials, like fabric, long asbestos, paper pulp and cotton cord	.015	.008

Tolerances for dimensions C and D of 1 in. and over: The tolerances in the above table increase in direct proportion to the basic dimension when 1 in. and over. Example: basic dimension C = $2^1/_2$ in. of short fibered materials. The commercial tolerance should be 2.5 × .008 in. = .020 inch.

Undercuts and sidewall drafts should be designed to allow the pieces to be easily stripped from the mold. It is more practical, however, to machine out undercuts after the pieces are molded for two reasons: 1) in laminate and macerate forms, the relatively poor flow characteristics do not allow full pressure in undercut sections, and result in a dry and rough appearance, and 2) it is difficult to extract from the mold a piece which contains abrupt changes in wall thickness (A) or undercuts (B) as shown in Fig. 5. Sidewall drafts on outside walls and interior recesses are designed with a taper of not less than 1° to facilitate the removal of the pieces from the mold.

Fillets, webs and ribs are provided not only to improve the appearance but also to increase the strength of the molded pieces. Ribs on large, thin sections reduce warpage. Radii on both sides should be (*Please turn to page 132*)

Stock molds

SHEET ONE HUNDRED THIRTY-TWO

In limited quantities, household items such as serving trays and bowls, cookie set, and salad set are available for attractive premiums. Containers, having chemical resistance and limited moisture transmission properties are suitable for ink bottles, medical preparations, etc.

1541. Large salad bowl, 10 1/2 in. diameter; 3 1/8 in. deep. Available in four colors: pearl, garnet, topaz, emerald

1542. Serving or hostess tray with delicately engraved decoration. Size: 15 1/4 in. long; 9 in. wide; 1 in. deep. Available in emerald, topaz, pearl, garnet

1543. Oblong relish dish, 8 1/4 in. long; 4 1/4 in. wide; 3/4 in. deep

1544. Individual cereal dish or salad bowl, in emerald, topaz, pearl or garnet. Is 5 1/4 in. in diameter; 1 5/8 in. deep

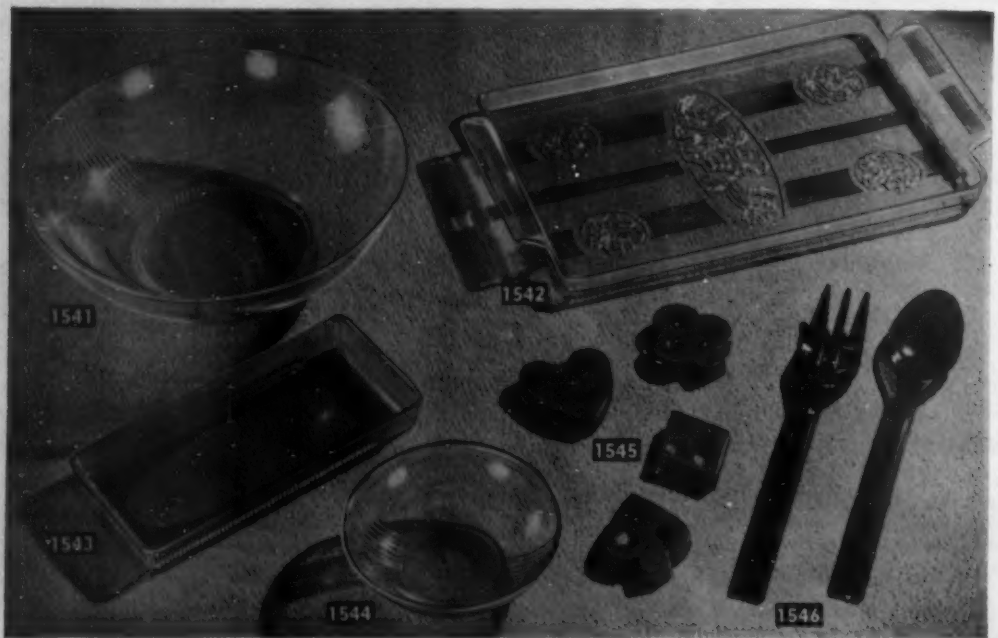
1545. Four-piece bridge-set cookie cutters in red, yellow, blue and green. Diameter 2 5/8 in.; 1/2 in. high

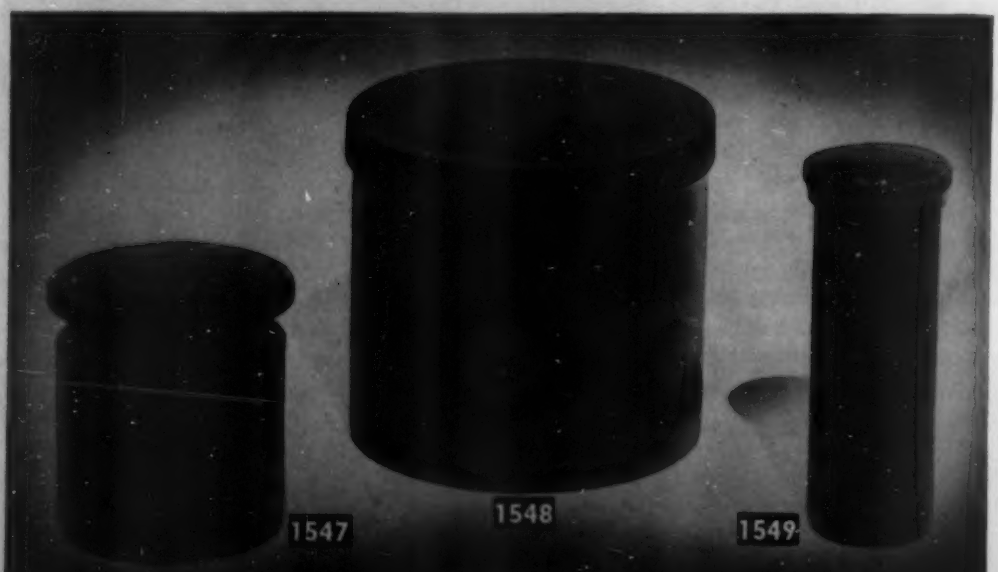
1546. Fork and spoon in assorted pastel shades. Is 10 3/4 in. long

1547. Black ink bottle, 1 3/8 in. diameter; 1 1/2 in. deep, threaded cover

1548. Black 2 oz. container, 2 3/8 in. diameter; 2 in. deep. Screw cover is bevelled around edge

1549. Black vial, 1/2 oz., is 3/4 in. in diameter, 2 1/2 in. deep. Has threaded cover of same material





These items are available from stock without mold cost, provided that restrictions on supplies of raw materials, etc., have not limited current production. For manufacturers' names and addresses, write Stock Mold Dept., Modern Plastics, Chanin Bldg., New York, N. Y.

Engineering properties of plastics*

by MAJOR F. B. FULLER†

THIS paper deals with the tensile, compressive, flexural, impact and creep characteristics at 77° F. and 50 percent relative humidity of a few important plastic laminates with structural possibilities in aircraft. The properties are merely indicative, due to the limited amount of test data, and have been obtained from flat panels and from structural parts. The test specimens and procedure were made in accordance with those outlined in standard practice for the U. S. Army Air Forces and now formulated in Federal Specification L-P-406, entitled "Plastics, Organic; General Specifications (Methods of Tests)."

The material, in general, was less than 1 in. thick and consisted of the following:

A. Commercial high-pressure phenol-formladehyde sheets, Federal Specification HH-P-256. These, developed mainly for electrical properties but still possessing good mechanical properties, were tested early in the development program for plastics:

Grade L—woven fabric less than 4 oz. per sq. yd.

Grade C—woven fabric exceeding 4 oz. per sq. yd.

Grade XX—paper base, 50 percent resin content.

B. Material developed for mechanical or structural properties; no applicable specifications:

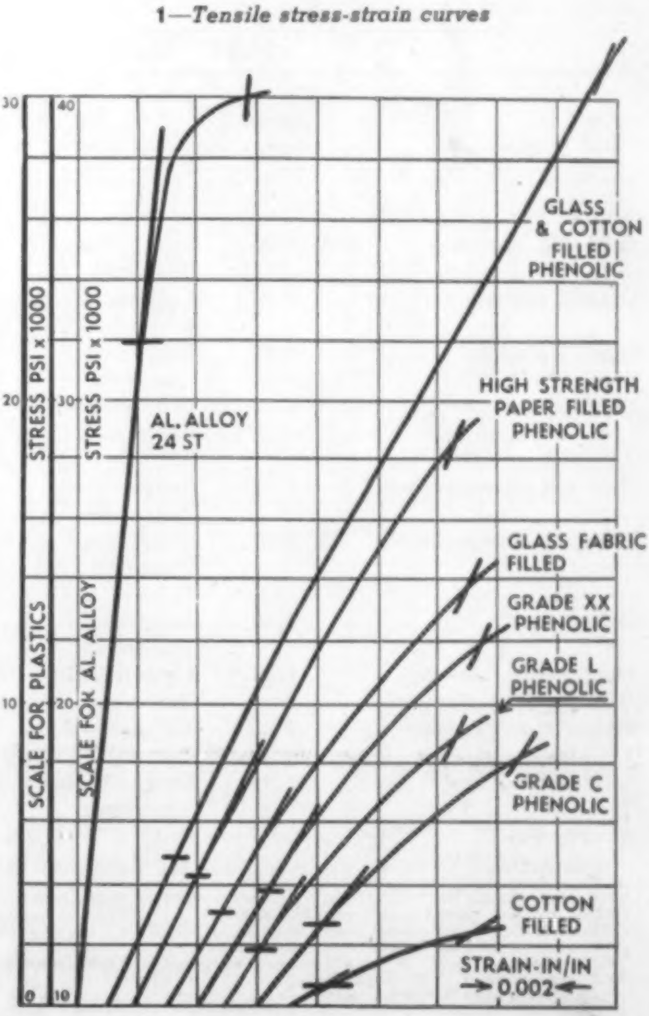
1. Sheet materials:
   - (a) Phenol-formaldehyde resin combined with cotton and glass fabric under high pressure and with high-strength paper under medium pressure (250 p.s.i.).
   - (b) Urea-formaldehyde resin combined with either glass or cotton fabric under low pressure (50 p.s.i.).
2. Material from structural parts:
   - (a) Flap and tab: high-pressure, fabric-filled phenol formaldehyde plastic.
   - (b) Pilot seat: medium-pressure (approximately 200 p.s.i.), fabric-filled urea-formaldehyde plastic.

In general, the complete history is available relative to resin, pressure, filler, temperature and fabrication except for the commercial Grades L, C and XX. The mechanical properties are presented in Tables I to IV and stress-strain curves in Figs. 1 and 2 in the same general form as used for metals in ANC-5, "Strength of Aircraft Elements." For comparison, data for heat-treated aluminum alloy are cited.

A few comments on the properties are offered as follows:

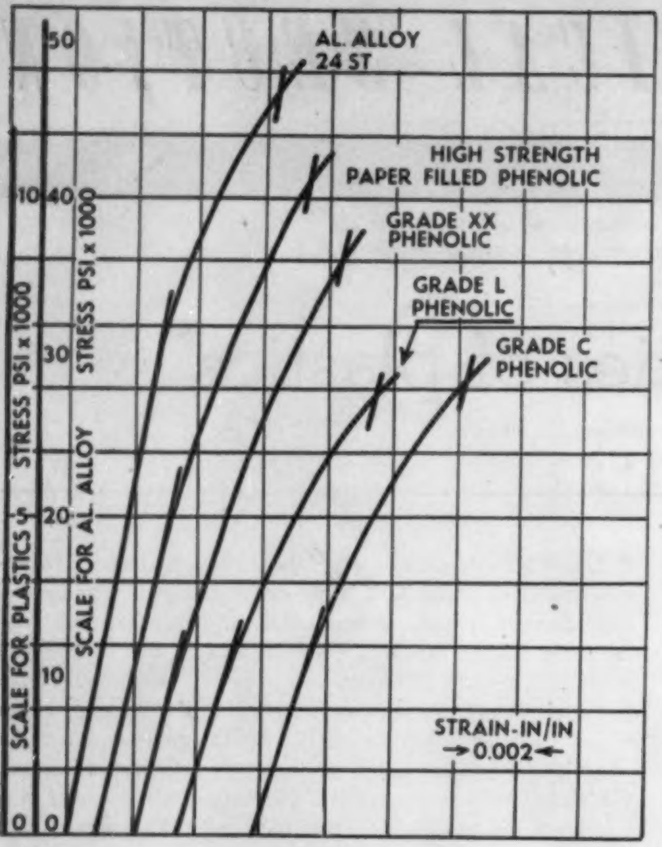
Tensile data and curves. The commercial grade materials C, L and XX are about comparable in density but the paper-base material, grade XX, is higher in strength. The special high-strength paper, although slightly heavier, has considerably higher strength properties than the commercial grades. The glass fabric groups, in general, are much higher in density than the above group and may average either higher than, or about comparable to, the commercial grades and high-strength paper in strength. The difference between the glass fabric laminates is a function of the type of filler (see footnotes of Table I), the resin and the pressure. The materials from the structural components, although about

1—*Tensile stress-strain curves*



* Paper presented at the ANC-Industry Conference, sponsored by the Army-Navy-Civil Technical Subcommittee on Plastics, held in Philadelphia on Feb. 9, 1943.

† Air Corps, Materials Laboratory, Wright Field.



2—*Compressive stress-strain curves*

comparable in density to the commercial laminates, were considerably lower in strength, irrespective of the pressure. On an equal weight basis, the phenolic glass fabric material is about comparable to aluminum alloy in ultimate strength, although lower in stiffness and elastic properties. The ductility of plastics, as measured by percentage of elongation, is considerably below that of the aluminum alloy.

In the stress-strain curves of Fig. 1, a direct comparison of the strength properties of the various plastics is readily made. The scale for the aluminum alloy is reduced in order to keep it on the same chart. Data obtained on plastics with gages of high precision and then plotted on large scales indicate an apparent straight line (modulus of elasticity) at the low stresses.

Compressive data and curves. Attention is called to the fact that the data herein are not those obtained on block or flatwise compression as used in the A.S.T.M. specifications, but rather those that are applicable to short and long columns as obtained on specimens with slenderness ratios from 11 to 15. In general, the ultimate strength and stiffness are higher than in tension with the exception of the glass fabric types, which are considerably lower. The latter is a result of poor bonding, as the material delaminated or separated. The blanks in Table II are due to the fact that tests were made for the ultimate strength only as length was not sufficient to mount gages. The proportional limit and yield strength were, in general, lower than those in tensile. Attention is called to the fact that the elastic properties, at least to the yield strength, are more important than the ultimate. On an equal weight basis, the aluminum alloy is considerably superior to the plastics.

TABLE I.—AVERAGE TENSILE PROPERTIES OF PLASTIC MATERIALS

Material	*Specific gravity*	*Direction*	*Proportional limit, tangential*	*Proportional limit, 0.01% offset*	*Yield strength, 0.2% offset*	*Ultimate strength*	*Modulus of elasticity*	*Elongation before fracture*
			p.s.i.	*p.s.i.*	*p.s.i.*	*p.s.i.*	*p.s.i.* $\times 10^{-6}$	%
Grade XX phenolic	1.34	Longitudinal	3,800	5,500	11,800	16,700	1.64	2
		Transverse	3,000	4,400	10,300	14,600	1.31	2
Grade C phenolic	1.34	Longitudinal	2,600	3,700	8,200	14,700	1.23	2
		Transverse	2,300	3,300	6,600	9,600	1.0	2
Grade L phenolic	1.34	Longitudinal	1,900	2,800	8,600	18,900	1.60	2
		Transverse	1,600	2,400	6,600	12,500	1.11	3
High-strength paper, phenolic	1.39	Longitudinal	4,300	6,700	18,400	24,600	2.20	1.5
		Transverse	4,400	7,200	19,000	24,200	2.18	1.5
		45°	3,900	6,400	18,200	26,100	2.24	2
Glass and cotton, phenolic[a]	1.64	Longitudinal	4,800	7,600	30,900	38,000	2.16	2
		Transverse	4,600	6,600	28,100	37,700	2.13	2
Glass fabric, urea-phenolic[b,c]	1.74	Longitudinal	3,300	4,600	13,700	27,400	1.76	3.5
		Transverse	3,900	5,500	13,000	19,700	1.14	2.5
		45°	1,500	1,900	4,900	10,400	0.86	4
Cotton, urea[d]	1.22	Longitudinal	700	900	2,500	5,100	0.56	22
		Transverse	600	800	1,900	6,900	0.53	8
Flap; cotton, phenolic[e]	1.28	Longitudinal	3,000	3,500	6,800	8,400	0.89	1
		Transverse	2,000	2,800	6,000	8,400	0.95	1-2
Tab; cotton, phenolic[f]	1.28	Longitudinal	1,000	1,600	5,000	6,100	0.81	2
		Transverse	....	...	....	10,100	...	2
Seat; cotton, urea[g]	1.40	Longitudinal	1,800	2,100	5,000	5,400	0.89	2
		Transverse	2,300	2,900	5,900	6,900	1.00	1
Al. alloy 24S-T[h]	2.77	....	32,000	...	40,000	62,000	10.5	15[i]

[a] Fiberglas fabric No. OC-63; glass warp, muslin fill; thread count, warp 54/in., fill 12/in.
[b] Copolymer urea-phenol-formaldehyde resin.
[c] Fiberglas fabric No. ECC-11-161; glass warp and fill; thread count, warp 29/in., fill 17/in.
[d] 6 oz. canvas; thread count, warp 38/in., fill 24/in.; modified urea-formaldehyde resin.
[e] 10 oz. cotton duck; thread count, warp 59/in., fill 32/in.; phenol-formaldehyde resin.
[f] Laminated phenolic, fabric base, fine weave.
[g] 8.5 oz. cotton fabric; 30 threads per inch warp and fill; modified urea-formaldehyde resin.
[h] Minimum values, ANC-5, sheet material.
[i] Elongation after fracture.

TABLE II.—AVERAGE COMPRESSIVE PROPERTIES OF PLASTIC MATERIALS

Material	*Specific gravity*	*Direction*	*Proportional limit, tangential*	*Proportional limit, 0.01% offset*	*Yield strength, 0.2% offset*	*Ultimate strength*	*Modulus of elasticity*
			p.s.i.	*p.s.i.*	*p.s.i.*	*p.s.i.*	*p.s.i.* $\times 10^{-6}$
Grade XX phenolic	1.34	Longitudinal	1,800	2,800	9,100	23,800	2.15
		Transverse	3,200	3,900	8,600	23,400	1.62
Grade C phenolic	1.34	Longitudinal	2,500	3,200	7,100	27,800	1.60
		Transverse	2,500	3,200	6,600	27,500	1.20
Grade L phenolic	1.34	Longitudinal	2,300	3,100	6,800	25,800	1.72
		Transverse	1,700	2,500	6,100	24,700	1.32
High-strength paper, phenolic	1.39	Longitudinal	3,100	5,400	10,200	22,700	2.33
Glass and cotton, phenolic[a]	1.64	Longitudinal	....	...	....	26,800	2.36
		Transverse	....	...	....	22,900	2.31
		45°	....	...	....	18,200	...
Glass fabric, urea-phenolic[b,c]	1.74	Longitudinal	....	...	....	6,600	...
Cotton, urea[d]	1.22	Longitudinal	....	...	....	7,000	...
		Transverse	....	...	....	8,700	...
Al. alloy 24S-T[e]	2.77	Longitudinal	30,000	...	46,500	....	10.68

[a] Fiberglas fabric No. OC-63; glass warp, muslin fill; thread count, warp 54/in., fill 12/in.
[b] Copolymer urea-phenol-formaldehyde resin.
[c] Fiberglas fabric No. ECC-11-161; glass warp and fill; thread count, warp 29/in., fill 17/in.
[d] 6 oz. canvas; thread count, warp 38/in., fill 24/in.; modified urea-formaldehyde resin.
[e] Values from NACA Report No. 840.

Flexural or bending data. No curves are presented since they follow about the same shape and trend as the tensile and compressive curves. In general, the proportional limit is higher than that in tension or compression but the stiffness is about comparable to that in tension. The maximum stresses in bending are higher than those in tension except for the glass fabric materials which are lower, probably due also to the result of poor bonding properties. The aluminum alloy is still high on an equal weight basis.

Creep and time-fracture data. This testing, which may be based on tensile, flexural, torsion or compressive loads, consists of loading specimens of the same material under different stresses and measuring the amount of deformation (creep) at intervals of time as well as time to failure. Data herein are based on tension, as it involves direct and uniform stressing of the cross section as contrasted to bending and torsion. A considerable amount of creep and fracture-time testing has been conducted abroad and in this country under the various types of loading, tensile predominating. Plastics, in general, in contrast to metals used in aircraft structures, may deform under constant load at room temperature even at low stresses or may fracture at a relatively small percentage of the load sustained by the standard short-time tensile test.

3—Creep of laminated phenolic material. 4—Creep of methyl methacrylate. 5—Tensile time-fracture tests

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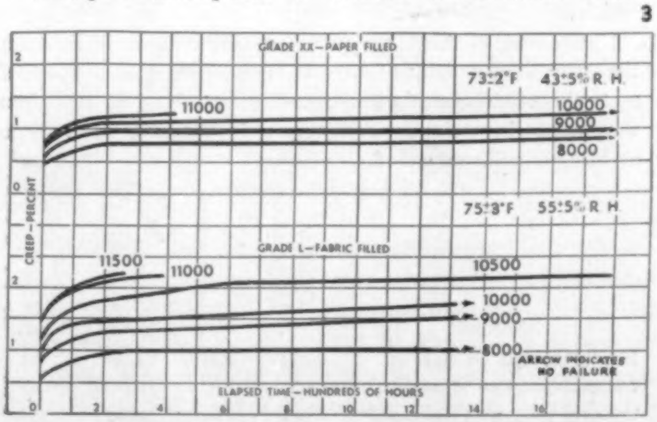

The data on creep presented in Fig. 3 indicate that for the same stress the paper-base material develops less creep than the fabric-base material, both being fabricated under high pressure with phenol-formaldehyde resin. Also, the amount of creep increases with increase in stress. It will be noted that the greatest part of the creep occurs in the early stages (during 100 hr.), after which it is practically unchanged; also, that at a stress of approximately 10,000 p.s.i. or less, no failure has occurred up to 1400 hours.

The curves shown in Fig. 4 for the methyl methacrylate are included to give a comparison (*Please turn to page 130*)

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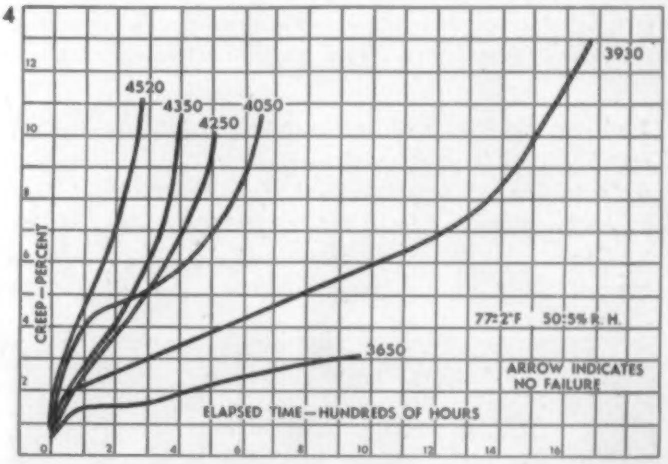

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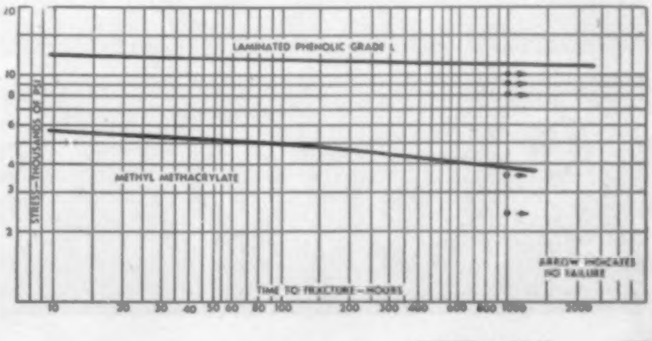


Improved heat-resistant methacrylate*

by G. M. KUETTEL†

THE widespread rôle of plastics in the war effort has done much toward accelerating the pace and widening the scope of plastics research. New plastics have been developed, and many have already made their appearance. Many of the "older plastics," too, have been improved in answer to war time needs. One such improvement in the methyl methacrylate field has been the development of a molding powder capable of yielding molded articles that will withstand service temperatures 30° to 50° F. higher than the service temperatures of articles molded from currently available methacrylate powders.

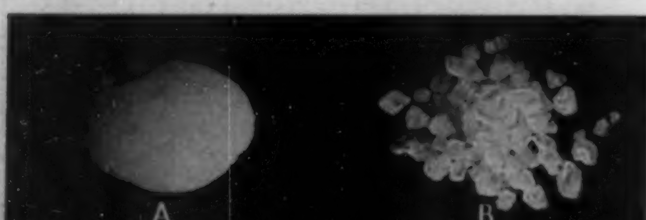
The methyl methacrylate molding powders are important members of the thermoplastic class of plastics. Their excellent transparency, good electrical properties, low specific gravity and ease of molding have resulted in their use in many important war items, such as gas-mask lenses, airport-marker lenses, blackout lenses, medical instruments, water filters and other articles.

We classify a plastic as thermoplastic if an article molded from it can, upon application of heat and pressure, be softened and remolded to shape. The property of thermoplasticity carries with it its own compensations and its own problems. Ease of molding, adaptability to various molding methods and the ability of being heat-softened for purposes of remolding constitute a few of the favorable aspects of the thermoplastic type of plastics.

A disadvantage of the thermoplastics, which minimizes their use in certain fields of application, is the fact that they are softened by heat. For this reason, much research effort has been devoted to improving the heat-resistance of the thermoplastics, and considerable progress has been made in this direction. This paper presents results of comparative tests on a new heat-resistant methacrylate formulation and a general-purpose type of methacrylate molding powder. In many of the tests, boiling water or an equivalent oven temperature is used as a convenient means of evaluation.

* This article is prepared from a speech delivered by Dr. Kuettel at the Annual Conference of the Society of the Plastics Industry held at Chicago, Ill., May 14, 1943 (see page 55).
† Technical Service, Plastics Div., E. I. du Pont de Nemours & Co., Inc.

1—*Two granulations of heat-resistant molding power: A, small-grained for compression molding; B, coarse-grained for extrusion or injection molding.* 2—*Effect of heat on tumblers molded from HM-119, HM-102 and HM-113.* 3—*Showing resistance to protracted dry heat in hot air oven at 212°F., of tumblers of injection-molded of HM-119*



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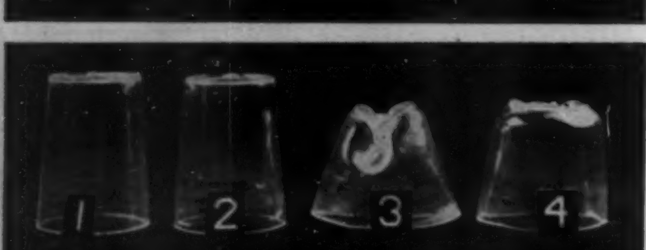

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The physical nature of the new heat-resistant molding powder is shown in Fig. 1. The material is available in two granulations, namely, a small-grained granular composition (A) adaptable to compression molding because of its low bulk density, and the coarse-grained material (B) adaptable to extrusion or injection molding conditions. The compression powder, coded HG-19, and the injection or extrusion powder, coded HM-119, can be used in present injection, compression or extrusion molding equipment, with no change other than the necessity of using a die or a cylinder temperature approximately 50° F. higher than would normally be used in the molding of the general-purpose formulas HM-102 and HM-113. It can be molded on the same cycles normally used, but the safe service temperature of the molded articles is from 30° to 50° F. higher than that of equivalent articles molded from the general-purpose types of methacrylates.

It should be noted that the tendency of a molded article to be distorted by heat, and the temperature at which such distortion develops, are influenced not only by the characteristics of the material of which it is made, but also by the strains which have been developed in it by its previous treatment, and particularly by the technique and conditions under which it has been molded. Some considerations to bear in mind when attempting to develop the best heat-resistance characteristics in the molded article are cylinder temperature, size and location of gate and the thickness of the molded article.

The effect of heat on tumblers injection-molded from the new heat-resistant and the general-purpose types of methyl methacrylate is illustrated in Fig. 2. The tumblers were made in a single-cavity die with a center gate. The molding conditions were:

Material	*Cylinder temperature* ° *F.*	*Die temperature* ° *F.*	*Pressure on material* *p.s.i.*	*Cycle* *sec.*
Heat-resistant (HM-119)	460	120	24,000	30
General-purpose (HM-102)	400	120	15,000	30
General-purpose (HM-113)	444	120	18,000	30

Tumbler 1 represents a HM-119 tumbler not subjected to heat. Tumbler 2 shows the results of boiling a tumbler made of this material for 10 minutes. This tumbler has been only slightly affected. Tumblers 3 and 4, molded from HM-102 and HM-113, are badly distorted with considerable decrease in height and development of deep folds along their sides. Tumblers were used as an extreme illustration of a long-flow thin-walled article. It must be remembered that at the present time the acrylics are not available for this use.

The resistance of injection-molded HM-119 tumblers to protracted dry heat is shown in Fig. 3. Tumbler 1 is the unheated sample. The other tumblers were heated in a hot air oven at 212° F. for the following periods. Tumbler 2—10 min. Tumbler 3—30 min. Tumbler 4—60 min. Tumbler 5—24 hr. The reasonable retention of dimensional shape over a period of 24 hours' continuous heating at 212° F. indicates the protracted resistance to elevated temperatures of the new molding composition.

Table I.—Dimensional Stability of Injection Molded Lenses in Boiling Water

Composition	*Treatment*	*Diameter*	*Dimensional change*
Heat-resistant formula		*in.*	%
HM-119	Control	2.42	...
	10-minute boil	2.35	3.1
General-purpose formula			
HM-102	Control	2.42	...
	10-minute boil	1.75	28.

Data on the effects of boiling water upon injection-molded heat-resistant lenses and the general purpose molded lenses are presented in Table I in terms of shrinkage in the direction of flow. The heat-resistant lenses decreased 3.1 percent in diameter, following a 10-min. boil, as compared to a 28 percent decrease in the lens molded from the general-purpose methacrylate powder. These data show the superiority of the heat-resistant molded lenses.

The property of improved heat-resistance is very clearly shown in Fig. 4, which portrays the effect of boiling water on extrusion-molded HM-119 rods as compared to the general-purpose methyl methacrylate composition HM-113. The top two rods represent the unheated samples. The middle two rods show the result of a 10-min. immersion in boiling water on the heat-resistant material and the general-purpose material. Note the decrease in length of the general-purpose rod and the curvature which has developed. The bottom two rods show the results of immersing the heat-resistant rod and the general-purpose rod in boiling water for 30 minutes. Here again, the absence of dimensional change in the HM-119 rod is to be noted in contrast to the continued dimensional change of the general-purpose rod.

Actual dimensional changes in the extruded rods pictured in Fig. 4 are shown in Table II. Even a 30-min. boil test failed to cause a change in length of the rod molded from

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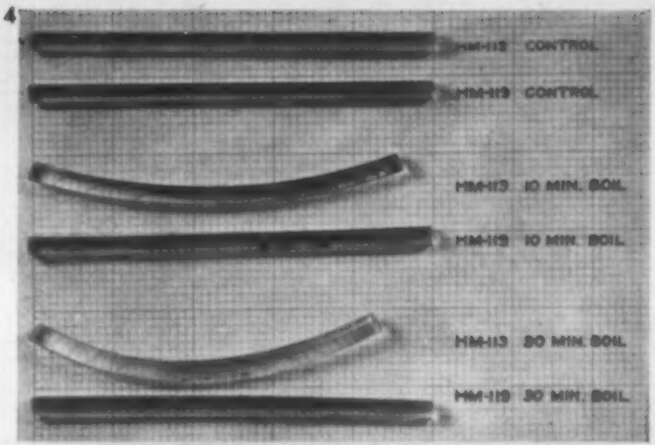

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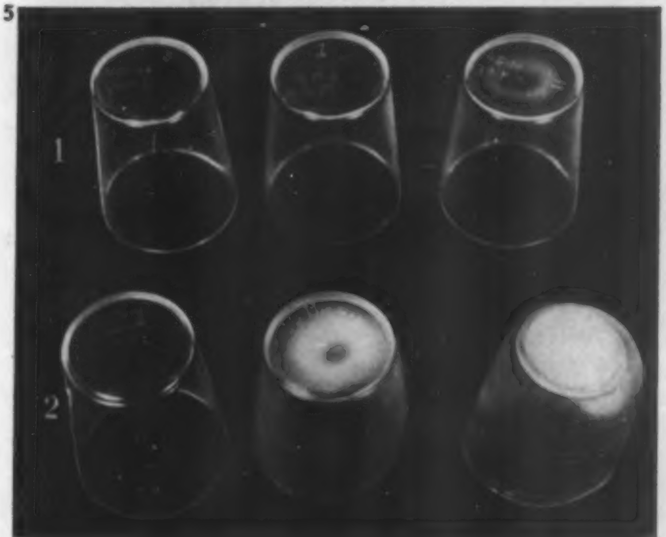

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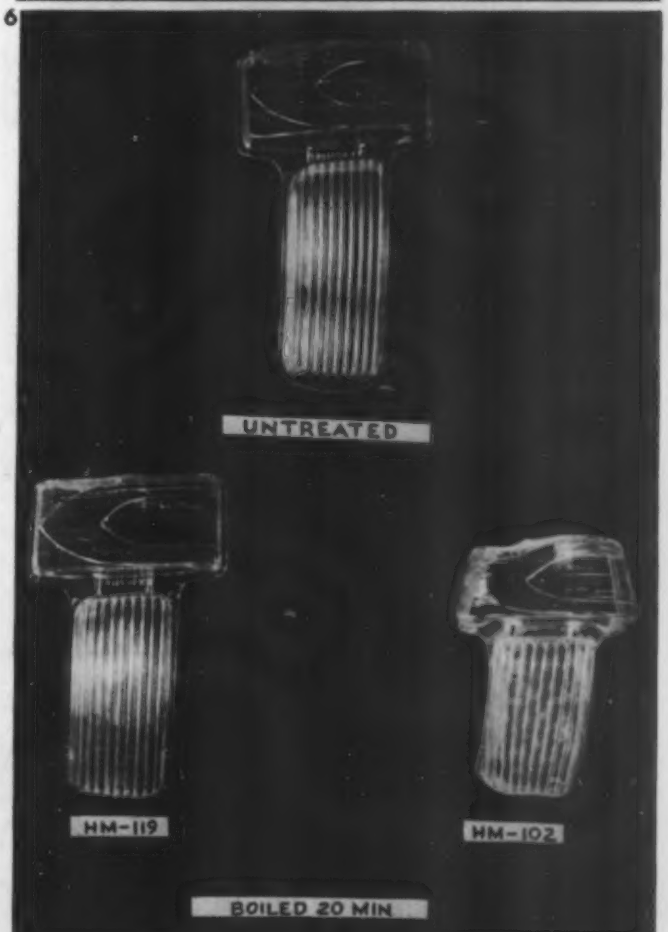

4—Effect of boiling water on extrusion-molded HM-119 rods compared to general-purpose methyl methacrylate composition, HM-113. 5—Tumblers heated at 212°F.: top row compression-molded of HG-19, bottom row of general-purpose methacrylate. 6—Illustrating comparative heat-resistance of injection-molded methyl methacrylate

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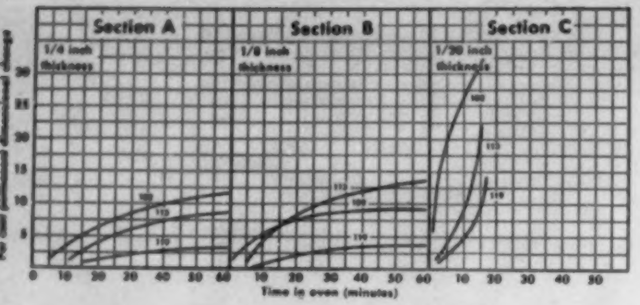

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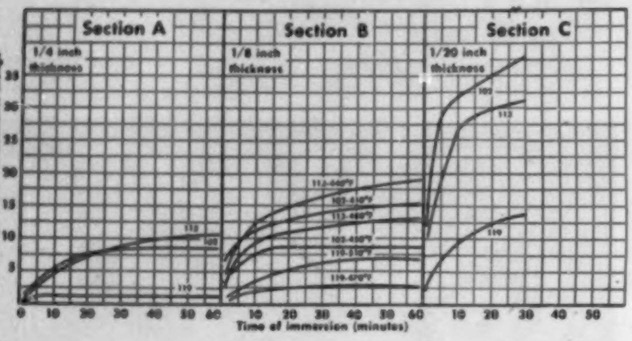

7—Results of immersing test bars of HM-113, HM-102 and HM-119 in boiling water over a varying length of time. 8—Tests to determine the effect of dry oven heat, 212°F., were charted according to the material employed. 9—Flow curves showing comparative flow properties of heat-resistant as compared to general-purpose formulation

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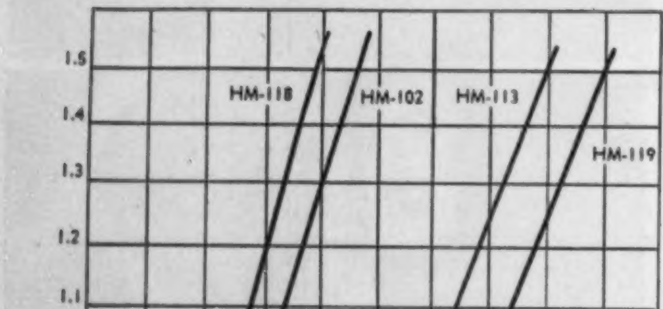


the heat-resistant formulation, whereas the general-purpose formulation showed an 8 percent decrease in length following a 10-min. boil, and a 14.5 percent decrease after a half-hour boiling period.

Test data are incomplete with regard to the effect of diameter versus heat-resistance, or relative rate of take-off or molding tension. From the information collected to date, however, it is felt that the heat-resistant molding compositions will open up new phases of application for extrusion-molded methyl methacrylates.

The beneficial effects of the new heat-resistant methyl methacrylate formula are obtained in the compression-molded formulation which, as a matter of fact, is a precursor to the injection or extrusion composition. In Fig. 5, the top row shows a series of tumblers, compression-molded of HG-19 heat-resistant compression-grade methyl methacrylate, that have been heated in air at 212° F. for various periods of time. The bottom row shows a series of tumblers of general-purpose methacrylate similarly treated. The pronounced distortional effects of the heat can be readily seen in the bottom row of tumblers. The center tumbler in each row has undergone a 10-min. test, and the tumblers to the extreme right in each row a 30-min. test. Side-wall ripples and unmolding in the base of the tumbler occurred to a much greater degree in the general-purpose compression material than in the heat-resistant material.

Figure 6 gives one more illustration of the comparative heat-resistance of an article injection-molded from heat-resistant methyl methacrylate. The top lens represents the control, that is, the unheated sample, and the other two

Table II.—Dimensional Stability of Extruded Rods in Boiling Water

Composition	*Treatment*	*Diameter*	*Dimensional change*
Heat-resistant formula		*in.*	%
HM-119	Control	5.00	...
	10-minute boil	5.00	0.0
	30-minute boil	5.00	0.0
General-purpose formula			
HM-113	Control	5.00	...
	10-minute boil	4.60	8.0
	30-minute boil	4.27	14.5

lenses, the results of 10 minutes' boiling. It can be readily seen which of these two lenses was molded from the heat-resistant stock.

To compare more completely the heat-resistance of the methyl methacrylate molding powder composition with that of the general-purpose grade of methacrylate molding powder, a series of test bars was injection molded. The bars were $^1/_4$-in.-thick impact bars 5 in. long, $^1/_8$-in. thick impact bars 5 in. long and $^1/_{20}$-in.-thick strips 2.5 in. long. One set of each of these bars was immersed in boiling water for 10 min., removed, and allowed to come to room temperature, and the distance between two previously etched lines was determined. The percentage change in length was calculated. A second group was immersed in boiling water for 20 min., removed, cooled, and measured. Similarly, other groups were immersed for the various periods shown as abscissae in Fig. 7. The percentage changes in length were plotted as ordinates. The dimensional changes of the two general-purpose methacrylates, (*Please turn to page 136*)

Allyl-type cast resins and laminates*

by ALPHONSE PECHUKAS, FRANKLIN STRAIN and WILLIAM R. DIAL†

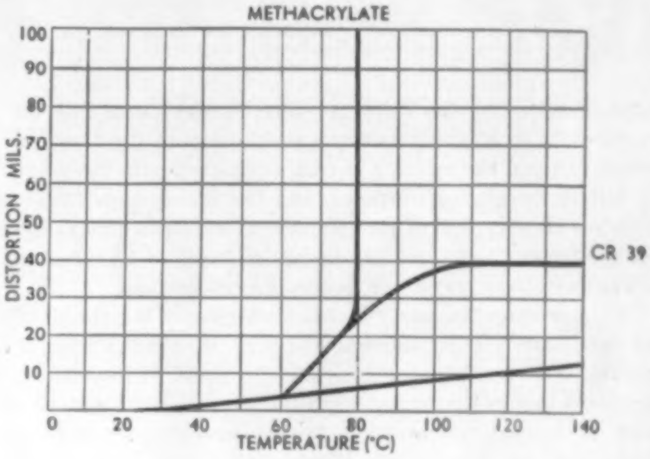
THE gap between the older common thermoplastics and thermosetting resins has been bridged by the introduction of new thermosetting compounds, such as C.R. 39. It is fortuitous that since the introduction of these compounds, materials based upon allyl alcohol have received the most widespread notice. Unfortunately, little can be divulged of the nature of these materials due to the imposition of secrecy orders. In general, the materials cure through catalysis by the same agents which activate other thermoplastic resin-forming monomers and evolve no gas during curing. The properties of the finished polymers, however, particularly with respect to those of solubility and fusibility, lie more closely toward the older thermosetting resins than those of the thermoplastic materials.

As can be readily appreciated, the resins based upon allyl alcohol comprise a broad family of chemical compounds differing from one another in specific properties but all possessing the characteristics of forming insoluble, infusible, resinous products through pure polymerization rather than condensation reactions. Parenthetically, it may be stated that a similar series of thermoplastic materials may be based on allyl alcohol but have not received much prominence. The group of materials studied thus far covers a wide range of reactivity and hardness, strength and flexibility of finished polymeric substances. Through adjustment in the chemical structure of the basic materials, these variations may be introduced to emphasize any particular property of the finished resin which may be demanded. One of the products, C.R. 39, represents an average picture of this family today. In general, three forms of these substances may be distinguished:

(a) the monomeric form and its polymerization products,
(b) transparent castings, and
(c) laminates prepared through the impregnation of fibrous materials, followed by polymerization of the monomer.

In general, the thermosetting monomers are clear, colorless liquids of relatively low viscosity which are soluble in most organic solvents but virtually insoluble in water. The monomers are stable at ordinary temperatures and may be stored for indefinite periods without substantial change if provision is made for eliminating excessive heating and contamination from outside sources. Upon heating in the presence of a catalyst these monomers increase in viscosity and pass into a syrupy, but not particularly tacky, stage. Upon continued heating a weak, friable gel is formed. This weak gel further hardens to produce hard, infusible, insoluble, substantially colorless solids. The polymerization process proceeds without the evolution of water, ammonia or other by-products. As can be readily appreciated, this property of the monomeric material allows the casting of transparent sheets free from the striations usually encountered in the casting grades of the condensation polymers.

In considering the reasons for the preparation of a thermo-



1—*Heat distortion of synthetic resins*

setting transparent material, it is obvious that the drawbacks of the common thermoplastics, low solvent resistance and distortion or flow under ambient and continued high temperatures, may be eliminated through the use of the thermosetting compounds. There are certain properties of the thermoplastic materials which should be preserved in a thermosetting transparent material and these are clarity of vision, resistance to abrasion, resistance to crazing, low weight, good aging characteristics and formability in the cured state. In the light of these requirements for transparent sheets, we may examine the allyl resins, as typified by C.R. 39, in comparison with an ideal material and the plastics now on the market. The clarity of C.R. 39 transparents is fully equal to that of the common thermoplastic types, since again a casting process is used for the production of these materials and no striations due to variations in polymerization are encountered. There is a slight yellow edge color in C.R. 39 which, however, does not influence the clarity of vision or total light transmission obtainable through sheets of any thickness now commonly employed. No evidence yet has been obtained for the crazing of C.R. 39 when held under stress, whether the sheets be exposed to solvent vapors or not. An all too common defect in some thermoplastic glazing materials, this phenomenon has never been encountered under any condition of use of transparent C.R. 39. The solvent resistance of C.R. 39 and its analogs appears to be that which may be predicted from the knowledge that the transparent material is a thermoset rather than a thermoplastic substance. Data obtained upon solvent resistance of this material as compared with a typical cast methacrylate were presented in a previous article.[1]

The abrasion resistance of the thermoset materials in this family appears remarkably high, although these resins can be sanded, cut, etc. When abrasion is studied as a function of mar resistance, C.R. 39 appears to be superior to any resinous material investigated. There are two types of abrasion which may be considered: the rubbing or mulling

* This article is prepared from a speech presented by Dr. Pechukas at the Annual Conference of the Society of the Plastics Industry, Chicago, Ill., May 13, 1943 (see page 55).
† Columbia Chemical Div., Pittsburgh Plate Glass Co.

1 "New Thermosetting Compounds," MODERN PLASTICS *20*, 88-90, 120, 122 (Oct. 1942).

Table I.—Properties of C.R. 39 Monomer

Tank life	Over 4 months
Boiling point	160° C. (320° F.) at 2 mm. Hg
Temperatures normally encountered during cure	70° to 115° C. (160° to 240° F.)
Odor at room temperature	Practically none
Viscosity at room temperature	Water, 1 centipoise C.R. 39, 15 centipoise Glycerin, 494 centipoise

type, as tested by the Taber Abrader, in which case C.R. 39 requires 30 to 40 times as many revolutions of the abrasive wheel to equal the marring of cast methacrylate to the point of failure for glazing purposes, and the falling emery type, which is more typical of abrasion due to windblown particles. In the latter case, C.R. 39 appears to be 8 to 12 times as abrasion resistant as the common cast methacrylates.

The low weight property of plastics in general is maintained in transparent C.R. 39, the polymer showing a specific gravity of 1.32 as compared with 2.5 for glass. The strength properties are in the range for most of the thermoset materials and at normal temperatures tensile strengths are slightly lower than for those of the thermoplastic type. The shock resistance of C.R. 39, however, compares favorably with the shock resistance of other transparent glazing materials.[1]

As indicated previously, some degree of formability should be necessary for most types of resinous glazing materials. In Fig. 1 are shown the curves typical of A.S.T.M. distortion measurements obtained by imposing a load upon a suspended bar of the plastic material. It will be noted that C.R. 38, one of the allyl resins, shows a distortion curve similar to that obtained for a thermoset resin of the usual type. For thermoplastic materials, such as cast methacrylate, the distortion resolves itself into a plastic flow. It is this property of plastic flow which allows the thermoplastics to be formed into curved shapes at elevated temperatures. In considering the curve for C.R. 39, it will be noted that, whereas a similar great deflection over a narrow temperature range is evidenced, a maximum distortion practically independent of temperature is reached. Thus, one would predict that C.R. 39 would be capable of being formed despite the fact that practically no plastic flow is evidenced. That the distortion is not accompanied by any great degree of plastic flow is evidenced by the fact that if the load be removed while the plastic material is hot the distortion will practically disappear. A sheet of material may be shaped while hot, in which case it is stressed and then cooled to freeze this deformation. Some spring-back is, of course, present but there is little tendency to lead to the initial flat state of C.R. 39 sheets if the formed materials are maintained in a very light frame. The degree of formability of C.R. 39 does not approach that of the common thermoplastic types of material, due to the virtual absence of plastic flow. Limited

Table II.—Physical Properties of Cast Allyl Resins and Laminates Bonded with Allyl Resins

Property	*C.R. 10*	*C.R. 38*	*C.R. 39*	*C.R. 41*
CAST RESINS				
Barcol hardness	49	45	21	0
Barcol cold flow	2	4	11	...
Flexural strength, p.s.i.	12,000	12,000	9500	880
Flexural modulus, p.s.i.	680,000	380,000	300,000	4900
Compressive strength, p.s.i.	23,600	27,050	22,100	3000
Impact strength, unnotched Izod, ft.-lb./in.	0.9	1.0	2.1	6.7
Water absorption:				
24 hr. at 25° C., %	0.2	0.3	0.2	0.8
168 hr. at 25° C., %	0.3	0.6	0.8	1.9
4 hr. at 100° C., %	0.7	0.8	0.7	2.8

Property	*C.R. 10* *Longitudinal*	*C.R. 10* *Transverse*	*C.R. 38* *Longitudinal*	*C.R. 38* *Transverse*	*C.R. 39* *Longitudinal*	*C.R. 39* *Transverse*	*C.R. 41* *Longitudinal*	*C.R. 41* *Transverse*
LAMINATES WITH NO. 360 COTTON SHEETING								
Barcol hardness	49		45		31		0	
Barcol cold flow	3		6		3		...	
Tensile strength, p. s. i.	10,400	5700	9500	5400	10,500	6200	5800	2200
Flexural strength, p.s.i.	15,600	...	17,800	8600	16,900	...	5900	5600
Flexural modulus, p.s.i.	...	...	570,000	150,000	620,000	...	150,000	350,000
Compressive strength, p.s.i.	22,100		39,600		29,500		12,300	
Impact strength, notched Izod, ft.-lb./in. of notch	1.9	0.9	2.0	1.2	2.0	1.3	4.0	2.9
Water absorption								
24 hr. at 25° C., %	0.6		0.8		1.2		4.5	
168 hr. at 25° C., %	1.5		1.9		2.9		6.4	
4 hr. at 100° C., %	1.2		1.5		3.0		5.7	
LAMINATES WITH ECC-11-148 FIBERGLAS								
Barcol hardness	58		41		39		0	
Barcol cold flow	4		5		5		...	
Tensile strength, p.s.i.	39,600	37,500	40,700	37,300	39,200	34,400	27,400	18,500
Flexural strength, p.s.i.	...	21,600	17,000	16,500	22,000	18,000	4200	4200
Flexural modulus, p.s.i.	...	1,480,000	1,510,000	1,260,000	1,410,000	1,630,000	310,000	280,000
Compressive strength, p.s.i.	...		50,900		52,200		25,400	
Impact strength, notched Izod, ft.-lb./in. of notch	14.8	14.2	16.7	15.7	16.2	16.0	13.6	12.9
Water absorption								
24 hr. at 25° C., %	0.5		0.9		0.8		2.7	
168 hr. at 25° C., %	0.6		1.5		1.0		2.8	
4 hr. at 100° C., %	0.4		1.5		0.8		2.8	

TABLE III.—PHYSICAL PROPERTIES OF CAST ALLYL RESINS AND LAMINATES BONDED WITH ALLYL RESINS

Property	*C.R. 38*	*C.R. 39*	*C.R. 39Bd*	*C.R. 140*
CAST RESINS				
Barcol hardness	45	21	31	36
Barcol cold flow	4	11	8	4
Flexural strength, p.s.i.	12,000	9500	20,100	13,200
Flexural modulus, p.s.i.	380,000	300,000	471,000	330,000
Compressive strength, p.s.i.	27,050	22,100	26,700	23,600
Impact strength, unnotched Izod, ft.-lb./in.	1.0	2.1	3.5	1.0
Water absorption				
24 hr. at 25° C., %	0.3	0.2	0.2	0.2
168 hr. at 25° C., %	0.6	0.8	0.7	0.5
4 hr. at 100° C., %	0.8	0.7	3.5	0.6
LAMINATES WITH ECC-11-128 FIBERGLAS				
Barcol hardness	49	..	..	47
Barcol cold flow	4	..	..	4
Tensile strength, p.s.i.	44,400	41,500	49,400	42,900
Flexural strength, p.s.i.	23,800	22,000	28,700	24,400
Flexural modulus, p.s.i.	1,950,000	1,750,000	2,080,000	2,080 000
Compressive strength, p.s.i.	55,300	60,000	63,100	58,000
Impact strength, notched Izod, ft.-lb./in. of notch	23.2	23	24.6	20.0
Water absorption				
24 hr. at 25° C., %	0.3	0.4	0.6	0.4
168 hr. at 25° C., %	0.7	0.9	...	1.0

radii of curvature may be obtained in both simple and compound shapes.

There are, of course, other special properties of this type of material which are more or less incidental to the properties to be considered for general application of a transparent material. For example, the burning rate of C.R. 39 is approximately one-third that of the cast acrylic resins. These materials have been reported as good photoelastic substances, since the sensitivity compares well with other materials, the fringes are more distinct and, of course, little optical creep is present. Other data on transparent C.R. 39 polymers have been published previously.[1]

One of the greatest interests in the new type of thermosetting materials, as represented by the allyl resins, has resulted from the applicability of these products to the preparation of non-structural, semi-structural and structural parts through the incorporation of fibrous fillers into the resin. One of the chief attractions for the laminators in this field of synthetic resins is the ease of manipulation of the compositions in the formation of large and complicated shapes. Referring back to the polymerization of this type of substance, it will be recalled that no volatile by-products are evolved during the curing of the resin. Thus, the materials are truly casting types and the only pressure necessary in laminating is that involved in keeping the plies of the various base materials in contact with one another. The low viscosity of the monomeric substances permits the complete impregnation of base materials with resinous products without the necessity of using solvents for carrying the resin to the base material. A paint brush technique employing the monomer is applicable and the materials appear to be ideally suited for bag molding techniques. At the present time these characteristics are of particular importance, since in a great many instances production runs of only a few thousand pieces are demanded. For the common high-pressure thermosetting resins, the manpower consumed in setting up large and complicated molds and presses may be far out of proportion to the value of the small number of identical pieces produced. With these materials, however, since simple molds constructed of papier-mâché, wood, concrete, and the like, may be used, many man hours may be saved when design changes require alterations of the particular parts. Since very large and complicated shapes may be made with a simple mold, fabrication techniques can be simplified over those employed for metallic objects, and at the present time manpower, which is of great importance, may be saved in aircraft construction and the like.

There are two phases of the application of these low-pressure thermosetting resins to the manufacture of laminated plastic parts which should merit consideration. First of all, the properties of the finished laminate are important, but the practical utilization of these resins is of equal importance. If these resins show merit in the production of laminated parts, it is obvious that the centralization of all of the phases of construction of these units, including the preparation of the monomeric material, the production of the laminated structures, the curing of these structures and the assembly of finished pieces, would be undesirable. The chemical producer is most suited for the production of monomers, while the resin molder, aircraft manufacturer and the like, is the logical producer of the finished laminates for application to current usages. In tailoring a low-pressure, thermosetting resin to fit these considerations, the stability of the monomeric material is of importance. The storage characteristics of the resins in their initial state must be appropriate for shipment and maintenance of stocks of resins without elaborate precautions to prevent losses due to polymerization. There are a great many compounds which would develop satisfactory properties in the cured state which should be eliminated on this consideration, since they are too active and may not be stored unless inhibitors which are difficult to remove are added to the material. The property of the allyl type of materials which is of great importance in this respect is the fact that these monomers may be stored practically indefinitely without change, and thus exhibit a very long tank life. At the same time the allyl family

TABLE IV.—PROPERTIES OF C.R. 39 LAMINATES
(77° F. except where otherwise indicated)

Property	Kraft paper Longitudinal	Kraft paper Transverse	8 oz. duck Longitudinal	8 oz. duck Transverse	Hurlbut 716 paper Longitudinal	Hurlbut 716 paper Transverse	Mitscherlich paper Longitudinal	Mitscherlich paper Transverse	Fiberglas OC-63 Longitudinal	Fiberglas OC-63 Transverse	Fiberglas ECC-11-148 Longitudinal	Fiberglas ECC-11-148 Transverse	Cast C.R. 39
Specific gravity	1.387		1.369		1.402		1.414		1.872		1.736		1.315
Tensile strength, p.s.i.	21,600	10,700	9000	7200	12,200	11,200	25,600	10,400	76,400	800	37,800	32,000	5000–6000
Flexural strength, p.s.i.	22,600	17,400	14,100	13,100	18,400	16,800	25,800	16,400	59,000	2000	24,600	25,400	9500
Flexural modulus, p.s.i.	1,100,000	780,000	420,000	360,000	940,000	810,000	2,090,000	815,000	4,040,000	850,000	1,480,000	1,180,000	280,000–350,000
Compressive strength, p.s.i.	31,400		29,200		31,800		29,200		15,000		48,000		22,100
Impact strength, notched Izod ft.-lb./in. of notch	0.91	0.61	3.2	2.1	1.0	0.98	1.1	0.90	23.9	10.0	25.0	15.7	0.31
Water absorption, 24 hr.													
Weight change, %	3.9		1.54		2.36		8.5		0.22		0.85		0.24
Length change, %	0.0		0.0		0.13		0.13		0.40		0.13		0.07
Width change, %	0.0		0.0		0.31		0.10		0.0		−0.40		0.00
Thickness change, %	1.5		0.0		0.69		0.18		0.58		0.0		0.25
Bonding strength, p.s.i.	255	226	429	370	287	294	166	167	217	198	286	266	...

appears to be capable of being readily activated to produce the polymerized material.

Other practical considerations may be cited. Since most of the resins are irritating to the eyes and skin when in the monomeric state, a material which is relatively non-volatile is highly desirable to prevent losses of resin by evaporation, changes in composition due to storage, and approaching the boiling point of the monomer during polymerization. The latter would result in the production of a spotty material. Viscosity considerations must also enter. One of the chief advantages of the new resin is the low viscosity and easy penetration obtainable with these monomers. Paint brush techniques are thus applicable. If the viscosity of the material is very high, difficulty may be anticipated in impregnation without the use of solvents and difficulty may also be encountered in the solution of the polymerization catalysts which are necessary. The properties of C.R. 39 monomer, which is typical of the allyl materials considered in this paper, are given in Table I.

Several important characteristics of the polymerized material must also be considered. Our experience has shown that in the production of laminated materials the choice of base materials is of utmost importance and that the influence of the particular resin used is secondary, except for very few characteristics. It is true, of course, that slight variations in tensile properties, bonding strength, etc., will occur from resin to resin to alter the arrangement of the desirability of materials slightly, but, in general, the most important properties of the finished laminates may be estimated from consideration of the properties of a base material and a few of the characteristics of the polymerized resin. In Tables II to IV are given the properties of a few base materials with various resins.

Laminates prepared with C.R. 39 show an interesting characteristic in this thermosetting family, which has been mentioned before in connection with the fabrication of clear sheets of this material. Upon heating to elevated temperatures it is possible to form sheets of the laminated materials into simple and compound curvatures of limited radii.

As with any new development, it is impossible to say that at the present time there has been developed in C.R. 39, or in any one of the allyl alcohol family of resins, the answer to all of the problems in the production of clear sheets, molded compositions or laminated structures. Many of the primary objectives have been satisfied but there are certain disadvantages as yet which should be mentioned for a clear understanding of the status of this field at the present time. The thermosetting materials of this type require relatively long cure times when compared with the ordinary molding type of thermosetting materials. The cure times are comparable to the casting grades of resins. The formability of the cured sheets is limited, although greater than that commonly assumed for thermosetting materials. Since these thermosetting compounds cure by pure polymerization reactions, a great many substances inhibit the cure of such resins. In the allyl type, for example, polymerization is inhibited by materials such as rubber, copper, mercury, water and the like. In certain specific applications, accordingly, these resins cannot be used where elements of rubber or copper are freely exposed to the curing material. One further point may be mentioned. At the present time the curing of the resins in contact with air is imperfect since air or oxygen exerts a marked inhibiting effect upon the polymerization. The defects *(Please turn to page 138)*

U. S. Marine cap insignia molded by American Insulator Corp.

TECHNICAL BRIEFS

Abstracts of articles on plastics in the world's scientific and engineering literature relating to properties and testing methods, or indicating significant trends and developments

Engineering

PROGRESS IN AIRCRAFT PLYWOOD, 1941–1942. T. D. Perry. Aeronautical Eng. Rev. *2*, 7–16 (Feb. 1943). This is a review of the progress in aircraft plywood during 1941 and 1942. The topics include: 1) improvements in resin adhesives, 2) pressure requirements, 3) temperature applications, 4) scarf jointing of plywood, 5) continuous veneer splicing equipment and 6) impregnation of veneers and paper plastics. Plywood is being used extensively in training planes, gliders, cargo planes and combat planes. Molded plywood by the flexible bag process is finding wide use in compound curved and monocoque shapes where flat plywood is wholly inadequate. More than 25 factories now have such molding equipment. The demand for flat plywood is taxing the capacity of nearly 100 factories. High-density and impregnated plywood are both finding growing recognition where hardness and strength are predominant. The use of radio frequency power for converting resin adhesives is extending rapidly. A candid appraisal of the situation indicates the definite adoption of plywood where strength/weight factors and workability are dominant, of metals where extreme strength is needed, of fabrics and of molded plastics where these materials are adequate. Thirty-six references.

PLASTIC SAFETY DEVICES REDUCE ACCIDENTS. D. S. Frederick. Am. Mach. *87*, 100–1 (Feb. 18, 1943). The use of machine safety guards made of transparent methyl methacrylate resin has resulted in a decrease in accident rates. Several applications are illustrated.

PLASTICS AND PAPER. R. V. V. Nicholls. Can. Chem. and Process Ind. *27*, 122–4 (Mar. 1943). Plastics produced from wood products are discussed. These include the cellulose derivatives, the lignin resins, terpene resins, rosin and paper laminated plastics. The contributions of plastics to the paper industry are also discussed. Fifty-nine references.

EFFECT OF FIRE-RETARDANT CHEMICALS ON GLUES USED IN PLYWOOD MANUFACTURE. J. M. Black. Dept. Agriculture, Forest Service Report No. R1427, 25 pp. (Mar. 1943). Yellow birch veneers were impregnated with the following fire-retardant chemicals: 1) monoammonium phosphate, 2) diammonium phosphate, 3) a mixture of 2 parts diammonium phosphate and 1 part monoammonium phosphate, 4) ammonium sulfate, 5) boric acid, 6) borax and 7) ammonium sulfamate. The veneers were bonded with 7 cold-setting and hot-setting urea-formaldehyde and phenol-formaldehyde resins and the shear strength of the resulting plywood determined. The effect of the fire-retardant chemicals on the pH was also determined. The chemicals made the veneers stiffer. The veneers treated with boric acid and borax were too stiff to run through a mechanical glue spreader. Borax, because of the high pH, was the only chemical which retarded the bonding of the cold-setting urea-formaldehyde resinous glues. The results with hot-setting urea resin glues were poor except those with ammonium sulfate. Poor bonds were obtained in every case with the cold-setting phenolics. The bond strengths obtained with hot-setting phenolics were poor with borax, boric acid and ammonium sulfate, and were fair with the others. The best results were obtained with hot-setting phenolics with veneers impregnated with monoammonium phosphate and ammonium sulfamate. In general, borax and boric acid caused the most trouble in attempts to get successful bonds, because of the high and low pH's, respectively. The resistance of all glues to water was decreased by presence of the fire retardant.

Properties

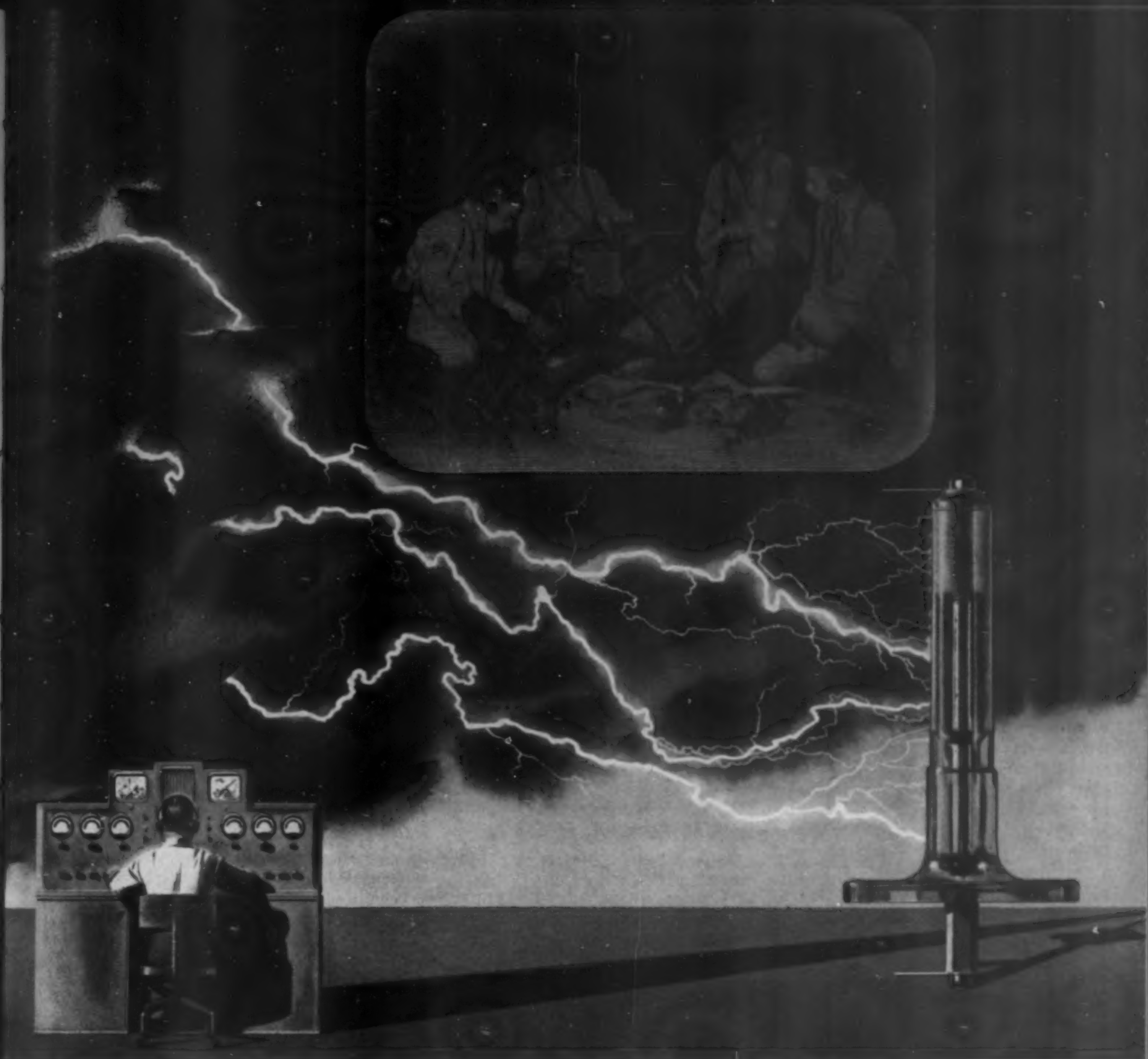
WATERPROOF GLUES. A. G. Knight. Wood (London) *7*, 109–12 (1942). The effects of moisture and microorganisms on wood adhesives were determined. Phenolic resin glues and all types of urea resin glues containing less than 33 percent flour were unaffected by microorganisms. Casein glues and urea resin glues containing more than 50 percent flour were affected. Attempts to improve the resistance of urea resin glues extended with 75 percent or more flour and casein glues by adding 0.75 to 2.5 percent of β-naphthol pentachlorophenol or its salts or copper chloride failed to improve the durability of the adhesive.

BRITTLE TEMPERATURE OF RUBBER UNDER VARIABLE STRESS. A. R. Kemp, F. S. Malm and G. G. Winspear. Ind. Eng. Chem. *35*, 488–92 (Apr. 1943). The temperature at which natural and synthetic elastomers fracture on bending depends on the rate of application and the magnitude of the stress applied. The slower the rate of bending and the less the angle of bend, the lower will be the temperature of fracture. A study of the stresses under varying types of service at subzero temperatures must be made in order to select intelligently the laboratory test conditions which will best simulate performance in the field. In the case of synthetic elastomers having high fracture temperatures, the addition of certain types of plasticizers serves to correct this difficulty. Vulcanized pure gum, natural rubber, plasticized polyvinyl chloride and plasticized polyvinyl chloride-acetate copolymer showed the largest changes (as high as 22° C.), whereas the compounded and vulcanized natural and synthetic rubbers involved in this study exhibited a reduction in brittle temperature from 5° to 10° C. in going from highest to lowest stress employed.

BEHAVIOR OF PLYWOOD UNDER REPEATED STRESSES. A. G. H. Dietz and H. Grinsfelder. Trans. A.S.-M.E. *65*, 187–191 (Apr. 1943). Results of tests under vibrating loads of birch plywood and laminated wood, bonded with hot-setting phenolic and cold-setting urea-formaldehyde resins, are presented. Fatigue failures were primarily wood failures. The materials may be expected to withstand at least two million stress reversals without failing when stressed to 25 percent or less of static modulus of rupture.

EXTENSIBILITY OF PLASTIC FILMS. W. Fischer and E. Witte. Kunststoffe *32*, 110 (Apr. 1942). The extensibilities of polystyrene, polyvinyl chloride, cellulose triacetate and polyamide films, 20 to 40 microns thick, were measured on a tensile machine. Polystyrene films were then cemented with an acrylic resin to films of the other three materials and the extensibilities of these constructions were determined. It was found that the polystyrene films cemented to the other materials have greater extensibilities than polystyrene film alone. The elongation at break is determined essentially by the film cemented to the polystyrene. The true extensibility of polystyrene film is found when it is cemented to the other films since influence of weak points is minimized.

SURFACE CURRENTS ON SYNTHETIC MATERIALS. H. Vieweg and H. Klingelhöffer. Kunststoffe *32*, 77 (Mar. 1942). The surface currents on compression molded test disks were measured. Dried specimens were exposed to dry ammonia gas, to 85 percent relative humidity and to wet ammonia gas, and the surface conductivities measured at various time intervals. Equilibrium was nearly reached after 6 to 10 hours. The specimens exposed to the wet ammonia gas had the greatest conductivity, those exposed to the moist air slightly less, those exposed to the dry ammonia gas the least. The change of conductivity with humidity and with temperature at high humidities was determined. An increase in humidity or temperature results in an increase in surface conductivity. It is concluded that the surface does not obtain charge carriers directly from the moisture in the air, but that the moisture causes formation of hydrated ions in the plastic.



PLASTICS DIGEST

This digest includes each month the more important articles of interest to those who make or use plastics. Mail request for periodicals mentioned directly to publishers

General

PROGRESS IN NEW SYNTHETIC TEXTILE FIBERS. H. R. Mauersberger. Rayon Textile Monthly *24*, 181–4 (Apr. 1943) A report of the progress in synthetic textile fibers since 1940. Included are fibers made from polyvinylidene chloride (Saran and Velon), polyvinyl resin (Vinyon E), casein (Aralac), soybean protein (Soylon), peanut protein fiber and plastic coated textile yarns (Plexon).

SYNTHETIC FLEXIBLE INSULATIONS. A. M. Ross. Gen. Elec. Rev. *46*, 212–18 (Apr. 1943). This article is a general discussion of the elastomers. The topics include polymerization, relation between molecular structure and properties, polycondensation, chemical sources and application to wire insulation. A chart is given which shows the chemical sources of many of the common plastics and elastomers. The properties which are of interest in insulating compounds are shown in a comparative chart.

TECHNICAL DATA ON "BUBBLFIL." J. B. Quig. Rayon Textile Monthly *24*, 77–8, 119–21 (Feb., Mar. 1943). The properties of Bubblfil, a regenerated cellulose product, are discussed and compared with those of kapok. Data on the tenacities and densities of the commercial grades of Bubblfil are given. The advantages, versatility and uses of this new material are discussed.

Materials

THE PREPARATION AND POLYMERIZATION OF METHYL VINYL KETONE. T. White and R. N. Haward. J. Chem. Soc. *1943*, 25–33 (Jan.). Methyl vinyl ketone may be polymerized to give a thermoplastic resin. A detailed study has been made of the acetone-formaldehyde condensation to establish the optimum conditions for the production of 3-ketobutanol, from which methyl vinyl ketone is obtained by dehydration. The condensation is complex and its various products are discussed and characterized.

PLASTICS FROM ACETYLENE. J. I. Jones. Chem. & Ind. *62*, 66–71 (Feb. 20, 1943). The synthesis of resins from acetylene is discussed. Various intermediates such as acetaldehyde, acetone, cuprene and many unsaturated derivatives are included. The resins discussed include various acrylics, synthetic rubbers and the vinyls.

SHELLAC IN INJECTION MOLDING. Y. Sankaranarayanan and H. K. Sen. J. Proc. Inst. Chem. (India) *13*, 145–60 (1941). The following procedure was found to yield a shellac composition suitable for injection molding small articles. Mix 300 parts of shellac, 200 parts of jute, 100 parts of kaolin or 300 parts of barytes, 15 parts of pigment and 9 parts of calcium stearate in dilute aqueous ammonia, dry, run through steam heated rolls, crush, and cure at 85° to 90° C. for $1^1/_2$ hours.

Applications

PLASTIC PUNCHES. C. Hill and J. McCanley. Tool Eng. *12*, 92–5 (Feb. 1943). Punches made of Plastalloy are compared with those made of Kirksite and lead. The preparation of the punches is discussed in detail. Although plastic punches cannot be used on all types of jobs, a saving results when they are used. Plastic punches are not very successful in ironing out wrinkles but when they are used fewer wrinkles are formed.

SYNTHETIC RUBBER LININGS FOR CONCRETE FUEL STORAGE TANKS. Chem. & Eng. News *21*, 580–3 (Apr. 25, 1943). Thiokol FA sheeting has been found suitable for lining concrete fuel storage tanks. The manufacture of the sheeting and its application are discussed and illustrated.

APPLICATION OF METHYL METHACRYLATE TO THE TOOTH. G. B. Salisbury. Dental Digest *49*, 14–17 (Jan. 1943). A new technic is described whereby methyl methacrylate polymer-monomer mix is packed directly into cavities and cured at mouth temperatures. The resin is stated to be superior to silicate in restorations both in permanence and in time consumed in laboratory and operative procedures.

Coatings

NEW COATINGS SPECIFICATIONS SAVE RAW MATERIALS. A. I. Totten, Jr. Chem. and Eng. News *21*, 370–2 (Mar. 25, 1943). The present status of Army coating specifications and the aims of the War Department regarding coating specifications are discussed. Projects are now underway on 1) standardization of testing procedures, 2) general simplification and consolidation of coating specifications, 3) reduction in the number of colors now in use, 4) processing and re-use of sludge material and 5) a study of wood finishing systems.

ADHESION OF LACQUER FILMS ON METALS. R. L. Savage, W. Von Fischer and C. F. Prutton. Paint, Oil Chem. Rev. *104*, 8–14, 16, 36–8 (Nov. 19, 1942). A new method for the direct measurement of adhesion of lacquer films to metal surfaces is described. The lacquer-coated surfaces are pressed together while still wet to make lap-jointed specimens. Wires 0.002 in. in diameter are imbedded in the lacquer film to control the space between the two pieces of metal. The specimens are pulled apart on a tensile testing machine. Resins with acid values ranging from 6 to 300 were combined with cellulose nitrate and applied to steel, zinc, aluminum and magnesium surfaces. The acid value of the resin had no marked effect on the adhesion of the lacquer film to the metal surfaces. Ten parts of resin combined with 100 parts of cellulose nitrate gave lacquer films with the greatest adhesion on steel; to obtain the best adhesion to zinc, 5 parts of resin are required. Increasing the amount of resin up to 20 parts resulted in increased adhesion to aluminum and decreased adhesion to magnesium. Lacquers consisting of 0.5 part stearic acid, 100 parts of cellulose nitrate and 10 parts of resin showed an improvement in adhesion to steel, zinc and aluminum and a decrease to magnesium with an increase in the acid value of the resin.

THE BEHAVIOR OF ELECTRIC INSULATING VARNISHES UNDER THE ACTION OF ALKALIS, ALKALINE EMULSION, GASOLINE AND KEROSENE. I. G. Limova. Izolyatsionnye Materialy, Org. Dielektriki, Trudy Vsesoyuz. Elektrotekh. Inst. *1940*, No. 38, 72–82. The effects of sodium hydroxide solutions, alkaline emulsions, kerosene and gasoline on phenol-formaldehyde, aniline-formaldehyde, alkyd, polyvinyl chloride, cellulose nitrate, benzylcellulose, oil-asphalt and chlorinated rubber varnish films on glass and on condenser paper were investigated. The films made of polyvinyl chloride and aniline-formaldehyde resin withstood the combined action of gasoline, kerosene and alkali, although they became brittle. Benzylcellulose, phenolic and polyvinyl chloride-alkyd varnish films were the most resistant to gasoline. Although aniline-formaldehyde and phenolic varnish films were the most resistant to kerosene, the strength properties were poor. The strength of film made from polyvinyl chloride combined with an alkyd resin containing perilla oil was not affected by a 500-hr. immersion in kerosene. In alkaline emulsions most of the varnish films swelled and lost their mechanical strength or were destroyed completely; satisfactory results were obtained with polyvinyl chloride, aniline-formaldehyde and chlorinated rubber films. Kerosene did not affect the electrical strength of the films.

CAMOUFLAGE PAINTS AND THEIR APPLICATION TO ROAD AND BUILDING SURFACES. L. G. Gabriel. Chem. & Ind. *62*, 3–6 (Jan. 2, 1943). The general characteristics of camouflage paints, their composition and applications are discussed.

Ewing Galloway

U. S. Plastics Patents

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 10 cents each

LINEAR POLYMER. W. E. Hanford and P. L. Salzberg (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,313,871, March 16. Forming linear polymers from substituted thioureas in which the substituent is a radical of an aliphatic or cyclic amine.

LIGNOCELLULOSE RESIN. W. K. Loughborough (to the Secretary of Agriculture of the U. S.). U. S. 2,313,953, March 16. Resinifying wood by soaking it in aqueous urea-formaldehyde solution, buffered to approximately pH 8.

INJECTION MOLDING. R. R. Bradshaw (to Dow Chemical Co.). U. S. 2,313,985, March 16. In molding organic thermoplastics by injection a composite thermoplastic sheet is inserted between injections; one face of the sheet becomes soft and tacky while the other remains hard under molding conditions.

PLASTIC TUBING. H. L. Brown (to Dow Chemical Co.). U. S. 2,313,986, March 16. Cutting flexible coils from plastic tubes.

OLEFIN RESINS. M. M. Barnett and J. H. Brown, Jr. (to Freeport Sulphur Co.). U. S. 2,314,067, March 16. Using diisobutene ozonide as catalyst in resinification of olefins, acetylenic hydrocarbons, vinyl acetate, allyl alcohol or allyl propionate.

PAVING COMPOSITION. H. Winterkorn (to Quaker Oats Co.). U. S. 2,314,181, March 16. Improving asphaltic paving compositions by mixing the asphalt and aggregate in presence of a resinifiable aldehyde.

GLAZING FABRIC. I. S. Hurd (to Rohm and Haas Co.). U. S. 2,314,277, March 16. Imparting a laundryfast glaze to fabrics with a cellulose ether, treated with a quaternary ammonium salt.

INK. C. Ellis (to Ellis Laboratories, Inc.). U. S. 2,314,307, March 16. A quick-setting ink, solid when cold, comprising a thermoplastic reaction product of phenol and sulfur chloride.

ADHESIVE. C. Ellis (to Ellis Laboratories, Inc.). U. S. 2,314,308, March 16. Thermosetting adhesives contain a urea resin and a hardening agent such as a nitroalkanol.

MOLDING FLASK. W. J. van Rossem (to Surgident, Ltd.). U. S. 2,314,377–8, March 23. A flask having a base of high heat conductivity and an upper part of low heat conductivity is used with thermoplastic resins in a fluent condition, the molded article being cooled from the inside out.

ALPHA CHLOROACRYLIC COMPOUNDS. J. W. C. C. Frodsham and N. McLeish (to Imperial Chemical Industries, Ltd.). U. S. 2,314,443, March 23. Destruction of antoxidation products in monomers of alpha chloroacrylic acid and its esters, by means of inorganic reducing agents and compounds containing a labile oxygen atom, followed by fractional distillation in the absence of oxygen.

WELL SCREEN. C. E. Bodey, Jr. (to Edward E. Johnson, Inc.). U. S. 2,314,477, March 23. Screen formed of arcuate bars of phenolic plastic.

DENTURE. U. S. Walton. U. S. 2,314,674, March 23. A denture with a moldable metallic reinforcement, having anchoring loops embedded in the molded article.

MOLDING APPARATUS. H. Z. Gora (to Jenkins Bros.). U. S. 2,314,823, March 23. A device for ejecting molded articles after molding.

COFFEE OIL RESINS. H. S. Polin, A. I. Nerkin and H. Wettingfeld (to Coffe X Corp.). U. S. 2,314,893, March 30. Resins obtained by separating volatile constituents and heating to a tough rubbery compound.

POLYMERIZATION OF CYCLOPENTADIENES. F. J. Soday and S. G. Trepp (to United Gas Improvement Co.). U. S. 2,314,903–4–8–9–10–11, March 30. Benzene soluble cyclic dienes polymerized by complexes formed by reacting suitable organic solvents with zinc chloride, aluminum chloride, ferric chloride, aluminum bromide, titanium tetrachloride, and stannic chloride, respectively. Further polymerization to the benzene insoluble polymer is prevented by inactivating the catalyst before this stage is reached.

TEXTILES IMPREGNATION. H. Bestian and G. von Finck (to General Aniline and Film Corp.). U. S. 2,314,968, March 30. Textiles are impregnated with substituted monomeric compounds of the *N*-ethylene, *N*-alkyl urea type, where the substituent is an aliphatic or isocyclic compound of at least 10 carbon atoms. The monomer is then polymerized.

FILAMENT FORMING POLYMERS. H. Dreyfus (to Celanese Corp. of America). U. S. 2,314,972, March 30. Formation of linear polymers, having ether linkages in the main chain and nitrogen containing side chains, from partially esterified amino derivatives of polyhydroxy compounds, containing two free hydroxy groups linked by a chain attached to a nitrogen containing radicle. Heating is carried out in oxygen free atmosphere.

FROSTED THERMOPLASTIC SURFACES. D. O. Ford (one tenth to O. E. Crocker). U. S. 2,314,975, March 30. Acrylic resin surface is degreased and placed in hot bath of dilute isopropyl alcohol, removed and dried with air blast until milky.

BONDING RUBBER TO FIBERS. I. Gazdik, E. T. Lessig and H. P. Headly (to B. F. Goodrich Co.). U. S. 2,314,976, 2,314,996–7–8, March 30. Cotton is treated with mild alkali before application of polyhydricphenolaldehyde-latex adhesive. Cord is treated with penetrant before applying resorcinol-formaldehyde-latex adhesive. Rubber is then vulcanized onto the fiber. This treatment is recommended for other natural and synthetic fibers.

ORNAMENTAL FABRICS. A. Lyem (to Celanese Corp. of America). U. S. 2,315,002, March 30. Local application of water soluble polyvinyl alcohol solution to fabric of cellulose

derivative, followed by treatment of uncoated area with volatile non-aqueous medium having shrinking action.

COFFEE PLASTICS. H. S. Polin. U. S. 2,315,005, March 30. Green coffee beans are treated so as to use fiber as a filler; oils are then treated with fiber and tannins under pressure and heated until a moldable product is obtained.

CHLORINATED PROPYLENE RESINS. L. A. Bannon (to Jasco, Inc.). U. S. 2,315,037, March 30. Propylene is polymerized by Friedel-Crafts type catalyst, followed by chlorination to give a thermoplastic resin of substantial chlorine content.

STABILIZER FOR CELLULOSIC MATERIALS. E. R. Littmann (to Standard Oil Development Co.). U. S. 2,315,-064, March 30. Treatment of cellulosic material with a mixture of a hydrocarbon oil bases, a soluble protective agent, and zinc naphthenate.

MOLD. H. E. McWane. U. S. 2,315,071, March 30. Mold body of high heat conductivity, water-jacketed, core extending into casting cavity, shank extending through aperture in body into jacket.

PHENOL-UREA-FORMALDEHYDE RESINS. Pierre Cuvier (vested in the Alien Property Custodian). U. S. 2,315,087, March 30. Partially condensing phenol and formaldehyde with alkaline catalyst, adding neutralized mixture of urea and formaldehyde and continuing condensation with catalyst of zinc, magnesium, lead, vanadium or manganese.

SHRINKPROOF PAPER. F. F. Newkirk (to American Reenforced Paper Co.). U. S. 2,315,128, March 30. Impregnation of kraft paper and polymerization, within its structure, of urea and formaldehyde. Union of two such sheets with asphalt in which reenforcing strands are embedded.

CELLULOSE ACETATE. R. Hofmann and W. Simson (vested in the Alien Property Custodian). U. S. 2,315,203, March 30. In acetylation of cellulose the catalyst, part of the acetic anhydride, and methylene chloride are sprayed on the material.

COATING COMPOSITION. W. K. Moffett (to E. I. du Pont de Nemours & Co., Inc.). U. S. 2,315,347, March 30. Coating containing cellulose nitrate, a non-drying vegetable oil modified alkyd resin, and an aliphatic dicarboxylic acid is highly resistant to oils and greases.

LIGHT POLARIZING IMAGES. E. H. Land (to Polaroid Corp.). U. S. 2,315,373, March 30. Wetting the relief of an image with a solution of a dichroic dye and pressing against a sheet of molecularly oriented, transparent plastic so that the dye is transferred from the relief to the sheet.

RESINOUS COMPOSITION. G. F. D'Alelio (to General Electric Co.). U. S. 2,315,400, March 30. Partial condensation at pH above 7.0 of an aliphatic aldehyde with a phenol having two reactive positions, followed by reaction with a cyanamide derivative at a pH below 7.0.

AMINOTRIAZINE-FORMALDEHYDE RESINS. G. F. D'Alelio (to General Electric Co.). U. S. 2,315,401-2, March 30. Use of oxamide as accelerator for an amino triazine formaldehyde resin. Preparation of a condensation product of aminotriazine, formaldehyde and a protein.

CAST PHENOLIC RESINS. E. L. Kropa (to American Cyanamid Co.). U. S. 2,315,432, March 30. Preparation of low temperature phenol-formaldehyde resin by heating phenol, formaldehyde solution and alkali solution at 60–80° C., evaporating water with vacuum, adding acid such as chloracetic, glycerine, followed by heating in molds at 80° C.

WEB SHEETING. F. A. Parkhurst (to Monsanto Chemical Co.). U. S. 2,315,477, March 30. Apparatus forms web of uniform thickness on endless belt which cools the sheet.

PLASTIC CONTAINERS. F. A. Parkhurst (to Monsanto Chemical Co.). U. S. 2,315,478, March 30. Method for forming hollow article in shape of a bottle from thermoplastic resins involves pressing of preform having walls of varying thickness, placing preform in a die, applying liquid pressure, heating externally so as to fuse the material, and cooling while under pressure so as to set the molded article.

COMPOSITE RESINS. W. S. Crowell and G. W. Birch (to S. S. White Dental Mfg. Co.). U. S. 2,315,503, April 6. A moldable composition having superior properties to constituent resins, these being polyvinyl chloride acetate and polymethyl methacrylate.

MOLDED PANEL. H. C. Guhl (to Westinghouse Electric and Mfg. Co.). U. S. 2,315,615, April 6 Panel composed of laminated sheets of kraft paper impregnated with resinous binder and having a surface sheet of alpha-pulp paper.

COATED STRANDS. E. E. Newton, C. A. Peachey and F. R. Reevely (to Western Electric Co., Inc.). U. S. 2,315,-645, April 6. Plastic coating is applied to strands, coating is aged at room temperature, compacted by pressure, and finally heat cured in a gaseous medium.

PAPER SIZING. E. Trommsdorff (to Rohm and Haas Co.). U. S. 2,315,675, April 6. Before formation of the web from cellulose pulp a water soluble salt of a copolymer of methacrylic acid and another substance is added.

SOYA OIL RESINS. A. G. Hovey, T. S. Hodgins and C. J. Meeske (to Reichhold Chemicals, Inc.). U. S. 2,315,708, April 6. Soya oil is heated, partially alcoholyzed, treated with pentaerythritol until alcoholysis is complete, then treated with additional pentaerythritol and phthalic anhydride so as to form a resin having an acid number less than 50.

UREA-FORMALDEHYDE ADHESIVE. W. C. Dearing and K. D. Meiser. U. S. 2,315,776, April 6. Adhesive of superior moisture resistance, consists of fine cellulosic particles in an aqueous solution of a urea-formaldehyde reaction product.

DIARYL ETHER SULFONIC ACID—FORMALDEHYDE POLYMERS. A. L. Fox and P. O. Bare (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,315,951, April 6. Condensation of diphenyl ether monosulfonic acid with formaldehyde is effected at a temperature low enough to avoid discoloration of the condensation product.

CELLULOSE ESTER COATINGS. C. J. Malm (to Eastman Kodak Co.). U. S. 2,315,973–4, April 6. Cellulose is prepared for esterification by presoaking in a lower fatty acid solution until activated, then treated with the acid anhydride; excess acid is removed by pressure. Coating of ester is applied to surface, melted on the surface, and another coating is applied which has good compatibility with the first.

PLASTIC LINOLEUM. F. J. Myers (to Resinous Products and Chemical Co.). U. S. 2,316,099, April 6. A fibrous base is coated with a tough layer of an oil-modified alkyd resin, filler, a reaction condensate of urea, formaldehyde and a monohydric alcohol, and an ester type plasticizer in which the condensate is soluble.

CASEIN PLASTICS. F. W. Adams and W. H. Lycan (to Pittsburgh Plate Glass Co.). U. S. 2,316,146, April 13. A composition of casein and a glycerol ester of levulinic acid.

(Please turn to next page)

POLYVINYL CHLORIDE COMPOSITION. A. B. Japs (to B. F. Goodrich Co.). U. S 2,316,169, April 13. A heat and light stable composition of a polymer of vinyl chloride and a partial ester of a polyhydric alcohol with an unsaturated fatty acid containing more than 10 carbon atoms.

POLYVINYL CHLORIDE COMPOSITION. H. Tucker (to B. F. Goodrich Co.). U. S. 2,316,196–7, April 13. Compositions of polyvinyl chloride with a chlorinated aromatic hydrocarbon solvent and maleic anhydride, and a chlorinated aromatic hydrocarbon solvent and a member of the class consisting of quinoline and isoquinoline in which at least one hydrogen has been replaced by hydroxyl.

CELLULOSE DERIVATIVE. W. Hentrich, W. Kaiser and R. Endres (to "Patchem A.-G.," Zurich, Switzerland). U. S. 2,316,242, April 13. A cellulose ether or ester plasticized with a water insoluble aliphatic or cycloaliphatic monosulfonamide substituted on the nitrogen atom only by alkyl radicals.

COATING COMPOSITION. J. A. Mitchell (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,316,274, April 13. A composition of cellulose nitrate, modified rosin, dibutyl phthalate, paraffin wax, benzoyl peroxide and cyclohexyl methacrylate.

MOLDING MATERIAL. R. P. Piperoux and D. G. Soussloff (to Celanese Corp. of America). U. S. 2,316,283, April 13. Granules are produced by slitting a sheet of heat-softened plastic material to ribbons and then cutting these to form granules of predetermined size and shape.

MULTIPLE CASTING MOLD. E. Strunk (to Alien Property Custodian). U. S. 2,316,298, April 13. Mold parts equipped with spaces for casting shaped bodies, feeder head, with feeder channels, which is movable relatively to the mold parts during the opening of the mold.

VINYL RESIN COATING. A. K. Doolittle (to Carbide and Carbon Chemicals Corp.). U. S. 2,316,323, April 13. Coating composition consisting of a copolymer of a vinyl halide and a vinyl ester of an aliphatic acid and an alkoxy-acetone solvent, compatible with coal tar hydrocarbons and adapted to retain solvent action for the resin in toluene.

PLASTIC COMPOSITIONS. C. O. Strother (to Carbide and Carbon Chemicals Corp.). U. S. 2,316,371, April 13. Thermoplastic resin is fused with a pyrone or pyronones of the same hardness of the resin so as to lower the fusion temperature of the composition.

ETHYLENE POLYMERS. B. J. Habgood (to Imperial Chemical Industries, Ltd.). U. S. 2,316,418, April 13. High molecular weight polymer of ethylene is mixed with carbon black yielding composition of greater tensile strength, hardness and electrical conductivity.

LAMINATED PRODUCTS. O. C. H. Sturken (to Corn Products Refining Co.). U. S. 2,316,467, April 13. Sheets of fibrous material, impregnated with a bitumen or a wax, are dipped into a cold solution of zein and bonded with pressure.

VINYL ESTER. K. H. W. Tuerck (to The Distillers Co., Ltd.). U. S. 2,316,472, April 13. Vinyl crotonate is formed by treating acetylene with crotonic acid in a solution with mercuric sulfate, acting as the catalyst, at a temperature of less than 30° C.

HALOGENATED ETHYLENE POLYMERS. D. Whittaker (to Imperial Chemical Industries, Ltd.). U. S. 2,316,481, April 13. A composition of a halogenated ethylene polymer and a substance such as salicylic acid, and an ester of an aromatic acid with a monohydric, dihydric or trihydric phenol.

CELLULOSE ESTERS. A. McAlvey (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,316,525, April 13. Cellulose is esterified in the presence of a complex of boron trifluoride, and an aliphatic acid having less than 5 carbon atoms, a complex of boron trifluoride and an alkyl ester of an aliphatic acid having less than 5 carbon atoms, and complexes of boron trifluoride and water with an alkyl ester of an aliphatic acid having less than 5 carbon atoms.

PLASTIC WINDOW SCREEN FRAME. A. W. McDonald, U. S. 2,316,526, April 13. Wire screen is embedded in a plastic frame.

POLYMERS OF ACETYLENE. O. Fuchs (to Alien Property Custodian). U. S. 2,316,536, April 13. Acetylene is passed through a catalytic solution of a cuprous salt, an alkali metal salt or ammonium salt and an organic compound of the class of aminocarboxylic acids, betaines, peptides or polypeptides.

2-HALOGENOBUTADIENE-1,3 POLYMERS. R. Kitani, N. Takashima and H. Kaneko (to General Electric Co.). U. S. 2,316,598, April 13. Process, consisting of partially polymerizing 2 chlorobutadiene-1,3 at 12° C. in an inert atmosphere, emulsifying foundation polymer thus formed, causing emulsified polymer to polymerize further and isolating the more highly polymerized portion.

PRINTING INK. H. P. Schmitz (to Alien Property Custodian). U. S. 2,316,629, April 13 Polyvinyl acetate which has been partially saponified and is water soluble is mixed with plasticizer and a basic dyestuff.

CONDENSATION OF ACETYLENE WITH DIMETHYLOL UREA. W. Reppe, E. Keyssner and O. Hecht (to General Aniline and Film Corp.). U. S. 2,316,653, April 13. Dimethylol urea is treated with acetylene at 20–120° C. and 1–40 atmospheres in the presence of acetylides or salts of heavy metals of the first and second groups of the periodic table.

POLYISOBUTYLENE PLASTICS. M. Mueller-Cunradi and W. Daniel (to Jasco Inc.). U. S. 2,316,706, April 13. Thin foils prepared by rolling at 80–100° C. are obtainable from a mixture of polyisobutylene, carbon black and graphite.

CELLULOSE ESTERS. G. D. Hiatt and L. Blanchard, Jr. (to Eastman Kodak Co.). U. S. 2,316,866, April 20. Cellulose esters are prepared by pretreating cellulose with nitromethane and acylating the anhydride of an aliphatic acid of 2–4 carbon atoms.

ARCHERY BOW. W. L. Miller. U. S. 2,316,880, April 20. A bow comprising a wooden base and a strip of thermosetting resin applied under a compressive strain when the bow is unbraced.

POLYVINYL ALCOHOL ACETALS. A. Weihe and F. Herrlein (to General Aniline and Film Corp.). U. S. 2,316,921, April 20. An aldehyde containing from 2–18 carbon atoms is reacted with polyvinyl alcohol with mixing, the acetylating being carried out in the presence of a strong mineral acid.

PLASTICIZING SYNTHETIC RUBBER. B. S. Garvey (to B. F. Goodrich Co.). U. S. 2,316,949, April 20. Rubbery polymer prepared by polymerizing a material consisting predominately of a conjugated butadiene hydrocarbon is plasticized with an aryl mercaptan.

ACID RESISTANT COATING. J. J. Mick and R. E. McCurdy (to B. F. Goodrich Co.). U. S. 2,317,076, April 20. Coating consisting of a homogeneous mixture of a copolymer of vinyl acetate and vinyl chloride together with polymerized coumarone.

TOOTH BRUSH. E. R. Person (to E. I. du Pont de Nemours and Co., Inc.). U. S. 2,317,110, April 20. A die having perforations in which packs of bristles are inserted and projecting into the mold cavity which is filled with thermoplastic material.

CASHEW NUT RESIN. J. L. Sheridan (to Custodi's Construction Co., Inc.). U. S. 2,317,116, April 20. Cashew nut shell liquid is reacted with an aldehyde in the presence of a benzene sulfonic acid and a benzene sulfonyl chloride.

Watch for THIS "Walkie-Talkie"

From the Drawing Boards of Sundberg and Ferar

TWO-WAY radio communication systems, like the plastic-cased beauty above, are one of the new developments leading industrial designers are thinking of to speed the work of a busy post-war world.

Applications of this compact, plastic-cased "walkie-talkie" are almost unlimited. A few of the most obvious uses would be for plant executives, construction gangs, firemen, police, forest rangers, and farmers or ranchers. Note how the top of the suggested molded plastic-case is formed by the head set. The carrying strap would also serve as an antenna.

Naturally, this is only one of thousands of uses plastics will be put to after the war, but it will serve to remind you that post-war planning *is* being done . . . and *must* be done *now*. We suggest that you talk over your ideas and problems with Kurz-Kasch designers, engineers, toolmakers, and molders . . . specialists for a generation in plastic planning and molding.

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IN THE NEWS

★ THE RECENTLY ESTABLISHED CANADIAN SECtion of the S.P.I. held its first official meeting on April 1 at the Royal York Hotel, Toronto. Members of the executive committee present were: A. E. Byrne, chairman; K. H. Braithwaite, vice-chairman; L. J. Falkenhagen, secretary; Ronald Kinnear, president; and William Cruse, exec. vice-president, S.P.I. At a meeting of this committee the following were appointed to the technical committee: chairman—J. L. Dean, Duplate Canada, Ltd.; vice-chairman—Dr. W. Gallay, National Research Council; secretary—Harry Gadd, Canadian General Electric Co. Ltd.; J. D. Benedito, Canadian Resins and Chemicals, Ltd.; W. A. Cambell, Bakelite Corp.; F. B. Farrell, Percy Hermant, Ltd.; P. Gunter, Mack Molding Co.; and R. D. Jackson, Joseph Stokes Rubber Co., Ltd. At the first meeting of this committee on May 5 discussion centered around wartime uses of plastics and technical developments, with representatives from the R.C.A.F., Navy, Army, Ordnance and Inspection Board of the United Kingdom and Canada.

At the general meeting on April 1, secretary L. J. Falkenhagen reported a total of 30 company, 16 individual and 3 professional members. A. E. Byrne, chairman, presided. Wm. Cruse described briefly the functions of the Controlled Materials Plan and outlined the close relationship the S.P.I. is maintaining with Washington. Information on company statistics, labor rates, sales facts, etc., are being compiled in coded form.

Dr. M. C. Milliken, general manager of Cellulose Products Div. of Hercules Powder Co. was the guest speaker, discussing the latest developments of his company in the plastics field.

DAVID S. HOPPING

W. DONALDSON

★ CELANESE CELLULOID CORP., 180 MADISON AVE., New York City, announce the appointment of David S. Hopping as head of its new sales development department. Mr. Hopping previously was director of sales of the packaging division. W. Richard Donaldson, former director of research for Turck, Hill & Co., was made director of market research. Another change was the moving of William F. Cullom from his position as district sales representative in Chicago to New York to head the films and foils division.

★ JOHN C. SEAGER AND RAYMOND BOYER WERE guest speakers at the sixth monthly meeting of the Plastic Engineers Association held at the Yale Club, New York City, on May 12. Chris Groos, president, introduced the speakers and announced that the next meeting will be held on June 14.

Mr. Seager, director of research, Raymond Loewy, Inc., spoke on "Bagasse Molding Compounds—Possible Applications and Their Composition." He emphasized the fact that this compound which employs the residue after the sugar has been removed from sugarcane, is entirely free of critical materials.

Raymond Boyer, Dow Chemical Co., discussed copolymerization as the development of the future. He likened the relationship of copolymers to polymers to that of alloys to steel.

★ THOMAS MASON CO., INC., OF STAMFORD, CONN., announces the change of its corporate name to Plastic Manufacturers, Inc. There will be no change in the corporate organization, operations, present officers or other personnel.

★ DOW CHEMICAL CO., MIDLAND, MICH., ANNOUNCE the appointment of D. L. Gibb as manager of the plastic sales division. A newly formed plastics development and service division will be managed by W. C. Goggin, previously engaged in fundamental research on resins, plastics and their application.

GEORGE W. DE BELL

★ GEORGE W. DE BELL, KNOWN TO THE PLASTICS industry for his adaptation of plastics to aircraft and other military equipment, has opened his own offices in the Gurley Bldg., Stamford, Conn., where as a consulting engineer he will specialize in all types of plastics engineering, die and mold construction, adapting plastics to special uses, and in plant operation and management. He leaves the Thomas Mason Co., where he has been employed for two years as chief engineer in charge of product design, tool design and tool manufacture.

Mr. DeBell, a native of Brooklyn, N. Y., was graduated from New York University in 1925 with a B.S. in mechanical engineering and two years later received his degree in aeronautical engineering. In 1925 he joined Aircraft Engineering, first as chief of structures and aerodynamics and later as project engineer in complete charge of all phases of aircraft design. In 1934, he went to the American Car & Foundry Co. to supervise aerodynamics and general design of streamlined trains. At various times he was engaged in a wind tunnel research program on air resistance of railway trains, in investigating the economies of dry ice for car refrigeration, and in developing new methods of railway car construction.

He became chief engineer with Fairchild Engine & Airplane Corp. in 1936, where he supervised the company's three types of aircraft construction: all metal, fabric-covered wood and steel, and plywood molded by the Duramold process. Through this last he became familiar with resin adhesives as employed in the bonding of plywood for structural airplane parts, and with molded plastic applications. At Fleetwings, Inc., where he supervised the design of airplanes and worked on proposals for radio-controlled planes, he gained a further knowledge of the application of various structural materials; and in 1940 he became project engineer of all plastics and plywood development and application for Glenn L. Martin Co. In two successive years (1940–41) Mr. DeBell's designs won for the latter company major awards in the annual Modern Plastics competition. As chief engineer for Thomas Mason Co., Inc., Mr. DeBell continued his work with aeronautical adaptations of plastic materials, and developed several specialized applications for military aircraft. *(Please turn to page 118)*

★ INDUSTRIAL DESIGNERS WORKING WITH WAR-developed plastics will be faced with the postwar problem of creating designs not only for an American public hungry for consumers' goods but for peoples in countries that never before imported American products on a large scale, Carl Sundberg told the Detroit Section of the Society of Plastic Engineers at their April 30 meeting.

Mr. Sundberg, of Sundberg & Ferar, industrial designers, said that technological advances have been stimulated greatly by the war and far in front in this development is a long list of new plastics and new plastic applications.

While warning of the dangers of overselling plastic products, Mr. Sundberg expressed a feeling that it is the designer's function to visualize and anticipate new peacetime applications and prepare hypothetical designs for them. He illustrated this belief with projections of some of his own postwar designs.

The second speaker was Robert J. Metzler, technical engineer of Hercules Powder Co., who explained the important part ethyl cellulose is playing in the production of American bombers and fighting planes, due to its extreme temperature range.

New officers of SPE (left to right): President Phillips, Vice-president Bachner and Secretary-treasurer Robb

★ AT A RECENT MEETING THE FOLLOWING OFFICERS were elected to head the SPE during the coming year: William Phillips, president; John J. Bachner, vice-president; and Philip F. Robb, secretary-treasurer.

Mr. Phillips, a chemical engineering graduate of the University of Pennsylvania, had his first experience with plastics during World War I, when he was general manager of Inland Manufacturing Co. which furnished shipyards with over a million parts made by electrodeposition on plastic cores. Subsequently, Mr. Phillips was employed by General Motors Corp., taking charge of the development of various types of finishes. This work led to the establishment in 1939 of a new department including rubber and plastics laboratories and all the electrochemical operations.

Following his graduation as a chemical engineer from Armour Institute of Technology, Mr. Bachner joined the chemical research division of General Plastics, Inc., working for 2 years on development and production of molding compounds. Then he returned to Chicago to work with the Chicago Molded Products Corp. of which he was elected director in 1939.

Mr. Robb has been continuously employed with the Hercules Powder Co. since his graduation with a B.S. in Chemistry from Pennsylvania State College except for several years service in the Field Artillery following the last war. Since 1934, Mr. Robb has been engaged in sales development of plastics and protective coatings working with cellulose nitrate.

★ LONG TERM PLANNING FOR POSTWAR INDUSTRY has been translated into action at the University of Kansas in Lawrence, Kansas, where a testing laboratory valued at approximately one-quarter million dollars will soon be in operation for the study of utilization and techniques of handling plastics. The building which will house the laboratory has already been completed, and the laboratory proper will start to function as soon as the necessary machinery and equipment now on order can be obtained. J. J. Jakosky, director of the University experiment station and chairman of the Kansas Industrial Development Commission's technical committee, will be in charge of the laboratory. Under the program outlined by him exhaustive tests will be made of Kansas-produced plastics to determine the tensile strengths, compressive strength and effects of heat and changes, as well as optical characteristics, resistance to acids and other agents and qualitative analysis of plastic materials. Both the laboratory and the results obtained will be available to any Kansas manufacturer interested in this field of development.

★ CARL E. HOLMES, FORMERLY CHIEF ENGINEER of Engineering Specialties Corp., is now head of his own company, American Plastics & Industrial Engineering Corp., located at 414 Curtis Bldg., Detroit, Mich. Associated with him are J. E. Morrison, former vice-president of Engineering Specialties, as vice-president, and W. L. Yaeger, former chief engineer of Standard Products Corp., Thermo-Plastics Div., as chief engineer. The new company will specialize in consulting, designing, developments and mold building.

★ DUE TO THE GREAT INTEREST CREATED AT THE October meeting of the A.S.M.E. by John P. Taylor's article on radio frequency heating as applied to plastic materials, the Chicago section of S.P.E. decided that a symposium on this subject would be of value. A galaxy of talent was gathered, including W. M. Witty, RCA Victor Div., Radio Corp. of America; Eugene Mittelmann, Illinois Tool Works; and James A. Boyajian, Instructor of Plastics Engineering, Northwestern Technological Institute with C. C. Henry as chairman.

Eugene Mittelman, speaking on "Experiences in the Industrial Applications of High Frequency Heating," discussed the fundamental principles upon which the practical applications of high frequency heating are based and upon which they depend. The following three factors were taken as fundamental:

1. The power absorption of the object to be heated as a function of the geometrical relationship between object and electrodes.

2. The time-temperature relationship for different amounts of power input.

3. The differences in conductivity and dielectric constant between the individual layers of the sample and their influence upon the temperature distribution.

Mr. Mittelman used several slides to illustrate the more complex points in his discussion. He also pointed out the possibilities of influencing a certain power distribution according to a desired geometrical pattern. He stated that it is possible to obtain within limits a certain desired temperature pattern within the sample and offered as proof several wood samples which had been purposely overheated. These samples showed a very distinct zone in the center which was actually charred and converted into charcoal, the outer layers remaining intact.

James A. Boyajian then gave the historical background of high frequency heating. At the turn of the century it was known that iron could be heated by being placed in a varying magnetic field. Early sources of AC to produce such fields were rotating generators. Mechanical limitations of such equipment imposed an upper limit of 15 kc. per second. Since it was known that the higher the frequency the greater the heat that would be produced, efforts were directed towards the development of suitable sources. This led to the evolution of the resonant spark-gap oscillator which was successfully used and, in fact, accounts for many practical installations for heat treatment of metals today. Spark-gap operating frequencies above 300 kc., however, are not generally used.

Since most plastic materials are very good insulators it is necessary that frequencies in the megacycle range be used, and therefore it was not until electronic equipment of sufficient power was developed that these nonconductors could be heated.

Mr. Witty's speech was carried as a feature article in the Engineering Section of the May issue of MODERN PLASTICS.

★ NATIONAL HEADQUARTERS OF THE SOCIETY OF Plastics Engineers announces the appointment of Stephen Hildebrandt, of Detroit, to head a national membership committee.

(*Please turn to page 120*)

OUR EXPERIENCE IS MADE TO ORDER FOR
Plastic Packaging

"To make a better package" . . . these are words thoroughly familiar to Owens-Illinois.

The experience of making billions of glass and metal containers stands behind the package innovations that have come from our Packaging Research Division.

Precision plastic molding for packages is an old story at Owens-Illinois. O-I plastic parts have added to the beauty and practicability of thousands of containers. These capacities, necessarily reserved for other purposes today, deserve to be noted and *underlined* on your post-war planning docket.

OWENS (I) ILLINOIS

PLASTICS DIVISION . . . OWENS-ILLINOIS GLASS COMPANY, TOLEDO, OHIO

★ DR. FRANK K. SCHOENFELD, FORMERLY IN charge of the Koroseal research and development laboratories of the B. F. Goodrich Co., has been named technical superintendent of the chemical division of the company. He succeeds Dr. Robert V. Yohe, now manager of Goodrich's Kentucky synthetic rubber plant.

★ R. D. WOOD CO., PHILADELPHIA, PA., ANNOUNCE the appointment of C. E. Powell as manager of the machinery department.

★ TO KEEP GOVERNMENT AGENCIES INFORMED OF the latest technical developments in its cellulose products, Hercules Powder Co. has opened a Washington office in Room 436, Southern Building, 15th and H Streets, N. W. The work of this office will be confined to technical matters and will not cover sales, allocations or other types of problems.

★ HERBERT A. T. SMITH, FORMER OFFICER AND director of Manufacturers Chemical Corp., has joined the sales development dept. of American Viscose Corp., Marcus Hook, Pa.

★ PLASTIC DIE AND TOOL CORP. HAVE MOVED INTO new offices at 2140 South Vermont Ave., Los Angeles, California.

★ ATLAS POWDER CO., WILMINGTON, DELAWARE, has announced the appointment of M. J. Creighton as general manager of the industrial chemicals department, in charge of research and development. Mr. Creighton will be succeeded as general manager of the company's cellulose products department by J. K. Weidig, who will be assisted by E. H. Bucy.

★ AT THE ANNUAL MEETING OF THE RUBBER AND Plastics Div., Montreal Section of the Society of Chemical Industry, held on April 9 at McGill University, the following 11 members were elected in a body for the 1943–44 executive: H. L. Blachford, Henry Chauvin, John Dunn, W. P. B. Gedye, Dr. R. S. Jane, Wilfred Jonah, A. B. Lewis, J. H. McCready, L. C. McLeod, J. R. Mills and E. W. Thorne. Officers will be selected later at a joint meeting of the retiring and incoming executive.

"Developments in the Functional Utilization of Plastics" was the subject of the guest speaker, H. K. Nason, assistant director of research, Monsanto Chemical Co. In addition to stressing the increasingly important wartime role of plastics, Mr. Nason presented slides showing the advances made in the last two years in accumulating comparative physical data for plastics and light metals used in aircraft.

★ J. M. McLEOD, FORMERLY ASSISTANT SALES manager of Hardinge Bros., Inc., has been appointed district manager of the company's Hartford office.

★ TO KEEP IN TOUCH WITH NEW TRENDS AND DEvelopments and to continue the study of plastics, the graduating class of the Plastics Industries Technical Institute has formed the Plastics Progress Club of New York. Composed mostly of business executives, the Club plans at its monthly meetings to invite as speakers engineers, molders, chemists, designers as well as manufacturers of plastic materials and molding machinery. Officers are Sydney J. Bryant, president, I. B. Rosenfeld, secretary, and Martin Greenblatt, treasurer.

★ CARTER PRODUCTS CORP., MAKERS OF EXTRUDED plastics, announce their removal to new and enlarged quarters at 6921 Carnegie Ave., Cleveland, Ohio.

★ A PROGRAM FOR THE MANUFACTURE OF SYNthetic waxes has been initiated by Warwick Chemical Co. of West Warwick, R. I., under the active direction of Dr. Ernest Stossel who has done research work in this line for many years. A new unit is now under construction for the manufacture of the waxes and for oxidation products of hydrocarbons made according to processes invented by Dr. Ernest Zerner, director of research and actively cooperating with Dr. Stossel in his program.

★ AIRCRAFT SCREW PRODUCTS CO., INC., LONG Island City, N. Y., announces the appointment of G. C. Brown as Detroit engineering representative.

★ THE FIRST COMPREHENSIVE COLLECTION OF war materiél of its kind to be shown in the country is on display at the Chrysler show rooms, 42nd St. at Lexington Ave., New York City. The exhibition is composed of a cross section of ordnance items of which a goodly number are manufactured by war plants in the New York and New Jersey areas. New pieces and various weapons collected from the Axis will be added as they become available. The exhibition is expected to continue through June. Admission is free.

★ COMPLETION OF THE SECOND ROHM & HAAS CO. plant for the manufacture of acrylonitrile, important organic constituent of the Buna-N synthetic rubbers, is expected shortly, making the fourth plant of its kind in operation in this country. The company's first plant was opened in 1940, the result of several years of interest in acrylonitrile as a copolymer with butadiene.

★ THE ARMY-NAVY PRODUCTION AWARD FOR excellence in the production of war equipment was presented on May 26, to the men and women employees of John Royle & Sons, makers of extruding machines, at their plant in Paterson, N. J.

★ AMERICAN MOLDING CO., SAN FRANCISCO, CALIF., announce the appointment of Fred L. Kennerley as general manager. For the past 14 years Mr. Kennerley has been San Francisco manager of C. D. LaMoree.

★ WITH SYNTHETIC RUBBER JUST BEGINNING TO come into the country's tire plants in volume, presenting many problems of changeover from natural rubber to synthetic rubber basis, the Detroit Rubber and Plastics group devoted their May 21 meeting to "Synthetic Rubber and Tires." The speakers, Dr. J. W. Temple and Dr. W. H. Hulswit of the compounding department, Detroit tire plant, United States Rubber Co., emphasized some of the differences between natural and synthetic rubber and discussed their effect on tire quality and manufacturing processes.

★ MONSANTO CHEMICAL CO., EVERETT, MASS., announce the appointment of Dr. Donald H. Powers to its Merrimac division staff as consultant on textile applications. Dr. Powers is a director of the Textile Research Institute, Inc., and a member of the American Chemical Society and the American Society for Testing Materials. Previously he was associated with Rohm and Haas.

★ STATE APPRENTICESHIP DIRECTORS FROM 9 states and the Territory of Hawaii, following a 5-day conference in Washington, have recommended the establishment of combination apprenticeship and high school systems. Designed to operate in every war production area, those trained would include boys in the 16 to 17 year old group, men over draft age or disqualified for combat duty because of dependants or physical ailments, soldiers released from service, and women.

It has come to the attention of the publisher of MODERN PLASTICS magazine that in numerous places throughout the country, molding and fabricating companies have been established under the name of Modern Plastics Co., Modern Plastics Inc., or similar titles.

We take this opportunity to state that MODERN PLASTICS magazine, published by Modern Plastics, Inc., has no interest whatsoever in any such company. Our sole interest is the publication of MODERN PLASTICS magazine.

PUBLICATIONS

Write directly to the publishers for these booklets. Unless otherwise specified, they will be mailed without charge to executives who request them on business stationery. Other books will be sent postpaid at the publishers' advertised prices

1942 Book of A.S.T.M. Standards

Published in 3 parts by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa.

Price: $27 complete; any one part $9 **4868 pages**

These three volumes contain all of the Society's widely used specifications and tests for materials, definitions, and recommended practices, in their latest approved form. Reference to previous issues of the Standards or their Supplements for details of the standard or tentative methods of test is unnecessary.

The subject matter of the Book of Standards is divided as follows: Part I. Metals—Specifications and methods of test for ferrous and non-ferrous metals, except methods of chemical analysis, which are published in a separate book on Chemical Analysis of Metals. Part II. Nonmetallic Materials, Constructional—Cementitious materials, concrete, masonry building units, ceramics, pipe and tile, thermal insulating materials, timber and timber preservatives, paints, varnishes and lacquers, road materials, waterproofing and roofing materials, soils. Part III. Nonmetallic Materials, General—Fuels, petroleum products, electrical insulating materials, rubber, textiles, soaps and detergents, paper, plastics, water, thermometers.

Each part contains its own table of contents and subject index. Part III includes 19 methods of tests for various properties of plastics, a recommended practice for conducting long-time tension tests and a classification of terms and descriptive nomenclature of objects made from plastics. G. M. K.

Henley's Twentieth Century Book of Formulas, Processes, and Trade Secrets

Edited by Gardner D. Hiscox

Norman W. Henley Publishing Co., 17 W. 45th St., New York, 1942

Price $4.00 **917 pages**

In compiling these formulas, the editors have endeavored to meet the practical requirements of the home and workshop. This revised edition contains new information on paints, varnishes, lacquers, plastics, polishes, photography and many other subjects. A glossary of chemical terms and their corresponding common names and several pages of useful information concerning the materials mentioned in the book should be helpful to many readers. Another handy feature is the list of names and addresses of dealers who can supply the various materials needed in preparing the compositions described. A very complete index to the ten thousand selected formulas makes it easy to locate the desired information in this reference book. G. M. K.

★ AN "INDEX TO A.S.T.M. STANDARDS, INCLUDING Tentative Standards," as of December 1942, may be obtained free of charge by writing A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa. The index is really an adjunct to the Book of Standards, enabling easy location of specifications and tests and determining whether standard specifications have been issued on a particular material or subject.

Metal Industries Catalog

Reinhold Publishing Corp., 330 West 42nd St., New York, 1942

First annual edition **318 pages, illustrated**

This catalog, the first annual edition, is a compilation of data and references which should be highly useful to those engaged in the metal and related industries. It is divided into three principal sections: engineering and metallurgical data; a manufacturers' catalog containing condensed catalog material of over 100 leading producers; and an all-inclusive, well arranged technical and scientific book section. The book is thoroughly indexed with an alphabetical listing of the firms whose products are catalogued, trade names, and a classification of equipment and supplies.

★ CARBIDE AND CARBON CHEMICALS CORP., NEW York, N. Y., have issued an attractive bulletin discussing Vinylite resins, their forms, properties and uses. The several different types of Vinylite resins are described as to their general characteristics, physical properties and applications. The cover of this 20-page book is protected by a surface coating based on a Vinylite copolymer resin, giving a high surface gloss. Other descriptive pamphlets available from the company deal with Vinylite plastic rigid sheet, thermosetting vinyl butyral spreader coatings and polyvinyl acetate resins.

★ TO HELP IMPROVE THE QUALITY AND INCREASE the quantity of articles molded from low loss phenolics, Bakelite Corp., New York, N. Y., has issued a manual stressing the attention which must be given the details of mold design, mold charge and mold operation. In addition to covering such items as type and location of cut-off; form, quantity and position of charge; mold temperature and molding time, there is a guide for correction of specific troubles which may be encountered.

★ "CELANESE IN THE POST-WAR WORLD" TELLS OF the new and growing uses for the plastic and textile products of the Celanese Corp. of America, 180 Madison Ave., New York, N. Y. There are full-page photographs of such plastic products as a lunch kit, developing trays and acetate-sealed glass ampoules. The section on possible uses for the company's plastics is like a glimpse into the post-war future.

★ THREE BOOKLETS HAVE BEEN PUBLISHED BY Hercules Powder Co., Wilmington, Del., "Hercolyn and Abalyn," "Flexalyn and Flexalyn C" and "Chlorinated Paraffin." In addition to discussion of general properties, a section in each is devoted to a description of applications. Numerous tables and charts are included.

"Production Control," first of a series of articles of interest to limited groups within the plastics industry, has been published by MODERN PLASTICS. Prepared by George V. Sammet, Jr., production engineer of Northern Industrial Chemical Co., this bulletin describes how one large molding plant operates under such new Government regulations as Production Requirements Plan, Controlled Materials Plan and Allocations. Copies may be obtained from the magazine for a nominal charge of 25 cents.

"Cutting Production Losses from Absenteeism," a bulletin issued by MODERN PLASTICS, was prepared by Lucille J. Buchanan, economic analyst, Division of Labor Standards, U. S. Department of Labor. On its 4 pages are summarized the experiences of many war industries and their opinions as to the best method of curbing absenteeism, whatever its cause. Copies may be obtained by writing to the magazine requesting bulletin No. 126. Ten cents covers the cost of handling and mailing.

Washington Round-Up

Current news, Government orders and regulations affecting the plastics industry, with analyses of the plastics situation

PROPOSED PRICE REGULATION FOR PLASTICS

A new regulation to establish maximum prices for resins and plastics sold at the manufacturers' level and purchased by anyone will soon be issued. In the proposed regulation prices of plastics materials now in existence and governed by GMPR will be established as maximum prices under the new order by simple statement of the fact. However, the new regulations will provide formula pricing methods for automatic pricing of any new plastic material offered for sale. They will be held to the general level of all prices that existed for similar materials in March 1942. There will be no necessity to apply for prices for experimental products.

In the pricing of new products the proposed regulations attempt to define and segregate all of them into one of four groups, namely: the same, nearly the same, related or nearly related, as compared to an older product. A specific method for pricing each group will be outlined. With the rapid changes now going on in material compounds, it is probable that almost every old product will become a new one through some change or other within the next year or two and thus come under the new pricing provisions of this order.

Eight months were spent in preparation of the new order. Many plastic industry leaders have been consulted as to its provisions. As a result of these consultations it was revised many times before it was first presented at an industry meeting. Every effort has been made to make the regulation workable by the OPA officials who have resins and plastics under their jurisdiction. The various rules and requirements in regard to record keeping and reports have been carefully designed to cause the industry the least possible inconvenience and at the same time enable administrators of the order to carry out their duties with prompt assurance.

In fact the coming issuance of this order can be taken as a symptom of the industry's growing importance—a further stepping stone in plastics' rise to maturity. Synthetic resins and plastics materials will now be taken out from under the jurisdiction of GMPR and put under a regulation designed and tailored to the needs of plastics. From now on, the plastics and resins industry will have an opportunity to build up its own special cases and interpretations in regard to price.

It is OPA's intent to remove eventually certain special products or groups of products now covered by the resins and plastics regulations and place these special products under regulations of their own in the form of amendments. Laminates and vulcanized fibre, for example, may require specialized handling and may get regulations setting special prices for those particular groups. When it becomes advisable to issue specific dollars and cents prices, they will be issued as amendments to this regulation and not on sometimes meaningless (as far as this industry is concerned) terms of GMPR.

The new regulations will also centralize price control in one unit of OPA and give the industry an OPA headquarters that may open a way toward centralization of control for all plastic products—including those of molders, laminators and fabricators who are now under MPR 136 and 220, GMPR and MPR 188 (consumer durable goods regulation).

UREA-FORMALDEHYDE ORDER

By the time this is printed, the urea-formaldehyde order may have been issued. It is not possible to discuss details of the order here, but it is important to point out some of the background that makes this order necessary. One particular purpose is to give WPB more direct control over the end use of formaldehyde so that it will not go into manufacture of nonessentials. Neither formaldehyde nor urea manufacturers nor WPB itself can be sure of the end use of these materials until they have been allocated for some specific purpose.

A molder who deals in only a few compounds or a manufacturer who makes only a few materials would be interested to see how WPB officials picture the entire industry. It is an involved and complex system whereby they funnel the right amount of a given product into the place where it is most needed without unbalancing the entire plastics production program. They must see that formaldehyde is distributed to the resin manufacturers where the end use will contribute most toward winning the war. They must watch, for example, formaldehyde, phenol, catalysts, solvents, fillers, electric or steam power, manpower, shipping containers and transportation all at the same time. If there is not enough of any one item available at a given place, serious production delays are inevitable. The urea-formaldehyde order is a step toward more efficient control of an important material in this balancing process.

Insofar as formaldehyde is concerned it will continue to be limited in its application to civilian items. Military uses are constantly increasing. Essential civilian uses such as plastic parts used in transportation and communication will continue to be provided, but all items of secondary essentiality will eventually be dropped. Both urea and formaldehyde are particularly tight at the moment, but urea is always tight in the spring. Unless adverse developments take place, additional formaldehyde will be available in 60 days, but it still won't be enough to satisfy all demand. It is doubtful that new facilities will be built, or would be even if steel were available, for *manpower is the big, future problem*. It would do no good to build new plants if no one could be found to operate them. Once more MODERN PLASTICS emphasizes that *manpower* problem. See that your replacement tables are in order and keep increasing your number of trainees.

INDUSTRY ADVISORY COMMITTEE MEETING

In what has been described by a participant as "the best meeting yet," the Organic Plastics and Resin Manufacturers' Industry Advisory Committee met in early May. They recommended that urea resins be distributed in a manner similar to phenolic resins and reported that all war requirements for urea resins were being satisfied, except for special dry adhesives.

They also suggested that the phenolic-resin order be amended to permit three-month allocations rather than one-month. Many molders will not be able to take advantage of this expedient because they are not able to anticipate what they will be manufacturing in three months. The three-month allocation will be most effective in connection with stabilized operations such as the manufacture of abrasive wheels, laminates and plywood. The longer allocation period would also save paper work and give a better opportunity to schedule production.

It was reported by producers of phenolic resins that delivery of their basic raw material has improved during the last four months. There are a few new phenol plants coming along—there will possibly be 30 per cent more phenol by the end of the year. But don't make a grand rush—it is still tight and will continue


Strength TO SPIN AT HIGH SPEEDS..
..ARMED
AGAINST CORROSION

so. A possible cellulose acetate flake order was also considered. In the suggested order, allocation requests would be filed by the producers similar to the plan now in effect in M-196 (nitrocellulose) with end use information supplied to the producer by molders with a certification of proposed use. The purpose would be to reduce the number of forms required by WPB. One of the problems before the order can be promulgated would be to find personnel for administration.

The Committee reported satisfactory operations with regard to Thermoplastic Order M-154, but the most misunderstood phase is the military exemption clause. Many firms are under the impression that orders placed by a post exchange or ship store are entitled to exemption. Such is *not* the case. Any such order, to be classed as a war order, must be certified as a direct military purchase in accordance with Priorities Regulation 17 and furthermore must be one of the items on the Exhibit A list which is entitled to a war use exemption, since a large majority of items are not in this category.

ESSENTIALITY OF PLASTIC GOODS

A letter mailed to the aviation industry by the Operating Committee on Aircraft Materials Conservation on "Availability of Phenolic Resins for Use in Aircraft Components" serves to point out the difference between essential and non-essential plastic products. What the letter says about phenolic resins and essential applications may also be applied to other plastics. Boiled down to a few words the letter indicates that:

1. If a new prospective use of a plastic material is indispensable, the plastic will be made available in the desired quantity. Thus if a new type plane is developed whose success is dependent upon a phenolic laminate in the landing gear, the necessary plastic materials would be found even if they have to be taken away from less essential military items.
2. If the use of plastics results in material improvement in performance of an item for the armed forces, sufficient material will probably be found.
3. If sound engineering indicates that plastics are fitted for a given application in an essential item and such use will result in a substantial saving in weight or in man hours for fabrication, every effort will be made to find the plastic material.
4. If a prospective application constitutes a direct substitution for metal without any other apparent advantage, plastics can seldom be used. Substitution would depend upon the critical state of the particular plastic and the end use. Certain phenolics have been allocated to replace extruded aluminum tubing when there was a lack of proper grade aluminum or not enough facilities to produce the required product. But such instances are few and far between. A request to substitute comparatively freer materials such as cellulose acetate, cellulose acetate butyrate, polyvinyl chloride and those formulations made from tailings would stand a better chance than relatively restricted methyl methacrylate or phenolics. But even these so-called freer materials may become critical in the future as increasing demand calls for their use in new applications.

Don't be too impatient with WPB rulings on essentiality. They are sitting virtually under the guns and can see what is happening. They know when a new military usage is going to require a huge amount of plastics tonnage, and it is their duty to find it if possible even at the expense of cutting into production of an article of prime essentiality.

FILM SCRAP GETS NEW PRICE CEILING

OPA will move to amend MPR 171 (Film Scrap) by placing a dollars and cents ceiling on X-ray and commercial film scrap. The former ceiling price included only nitro-cellulose or movie film scrap. The proposed new amendment will establish prices at the level of October 1941.

VESTED FOREIGN PLASTICS PATENTS AVAILABLE

The Alien Property Custodian is eager to get more vested enemy patents into the hands of American manufacturers. For lists of patents of interest to the plastics industry write to Alien Property Custodian, Field Building, Chicago, and ask for catalog sections on Class 260 Chemistry, carbon compounds; Class 18, plastics; Class 106, plastic compositions; Class 25, plastic block and earthenware apparatus; Class 207, plastic metal-working. The price of the catalog sections are: 25 cents for Class 260 and 10 cents each for the others. Full instruction for applying for licenses to use the seized patents will be sent with the catalog sections.

HOW TO OBTAIN MOLDS

For the benefit of molders who may be confused over obtaining molds through the War Production Board, we are printing a general review of the necessary procedure. Under CMP, molds for plastics may be considered as operating supplies whether title to the mold remains with the customer or the molder and may be purchased in accordance with CMP Regulation 5. If the molder fabricates his own molds he may purchase the steel for their fabrication by certifying on his purchase order the following endorsement:

"CMP allotment symbol MRO—The undersigned certifies, subject to the criminal penalties for misrepresentation contained in section 35 (A) of the United States Criminal Code, that the controlled materials covered by this order are required for essential maintenance, repair or operating supplies, to be used for a purpose listed in Schedule I or Schedule II of CMP Regulation No. 5 and that delivery thereof will not result in a violation of the quantity restrictions contained in paragraph (f) of said regulation."

If the molder has his molds made by an outside tool company, the molder should certify on his order the following endorsement:

"Preference rating . . . (specify rating)—MRO. The undersigned certifies, subject to the criminal penalties for misrepresentation contained in section 35 (A) of the United States Criminal Code, that the items covered by this order are required for essential maintenance, repair or operating supplies; that this order is rated and placed in compliance with CMP Regulation No. 5; and that the delivery requested will not result in a violation of the quantity restrictions contained in paragraph (f) of said regulation."

The rating supplied in this case will depend upon the molder's classification in the schedules attached to CMP Regulation No. 5. In either case, the total dollar value of purchases for maintenance, repair and operating supplies should not exceed the molder's quota as outlined in paragraph (f) of the regulation.

Before purchasing molds or fabricating steel for molds, the proper clearance should be obtained from the provisions of order L-159 by filing form PD 741 with WPB.

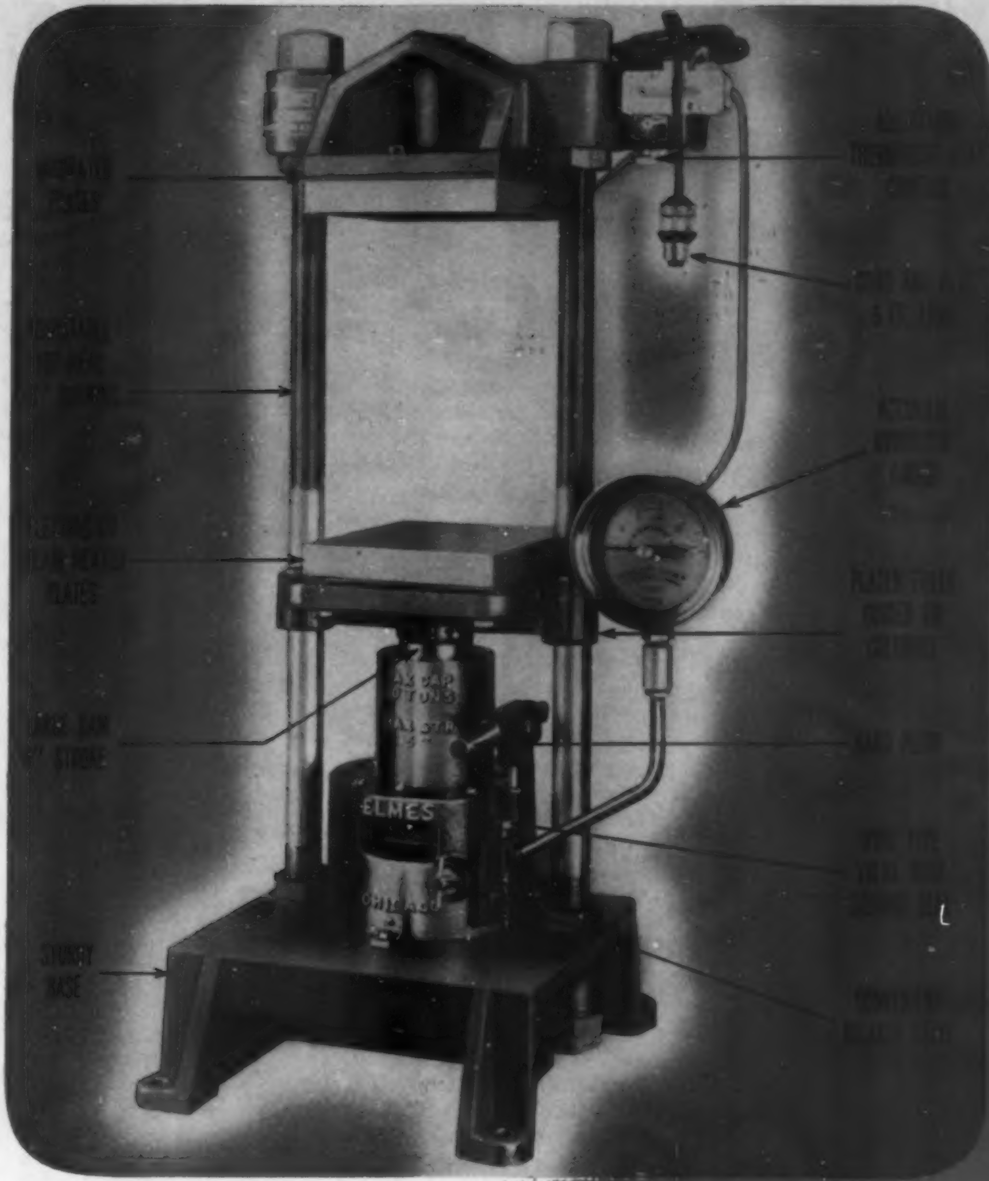
Note: The molder himself must file for molds—not *the molder's customer as the molder must answer certain questions in regard to equipment as asked on PD 741.*

NITROCELLULOSE ALLOCATIONS ELIMINATED

Because the supply and demand situation on soluble nitrocellulose has eased, WPB revoked General Preference Order M-196 on May 14, 1943. However, users of nitrocellulose should take note that this material *cannot* be employed for manufacture of prohibited articles under M-154. In other words, nitrocellulose is still limited to the manufacture of war and essential civilian goods only, but the manufacturer of such essential goods will no longer be required to apply for an allocation of nitrocellulose.

REPLACEMENT SCHEDULES ARE A NECESSITY

A great many employers in the industry have failed to make out their replacement schedules. We have learned from Government authorities of the grave necessity for complying with this procedure. If your replacement schedule is not in order, you will have to fight out each individual case, which is a time-consuming process. The schedule is the key form in obtaining protection from Selective Service for your most essential people. A replacement schedule is drawn up by the employer indicating his views as to the time and order by which each of his employees could be released to the armed services. Thus the employer can be more reasonably assured that his unskilled workers will be taken before skilled workers, (*Please turn to page 156*)



SEE THE MODERN FEATURES OF THIS "LAB" PRESS

Take a minute to study this picture. Here's a hydraulic press by Elmes that is meeting today's urgent needs in numerous commercial and scientific laboratories. It is being used for Blocking, Breaking Tests, Briquetting, Cake Forming, Forcing, Forming, Gluing, Laminating, Compression Tests, Dehydrating, Drawing, Embossing, Spring Testing, and a host of other jobs.

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MACHINERY and EQUIPMENT

★ A RADIO SEWING MACHINE FOR WORK ON THERmoplastics has been developed experimentally by RCA laboratories, Princeton, N. J. Instead of needle and thread, this machine uses radio-frequency current. The material to be "stitched" is fed across a table top through two roller wheels that pull the material along and act as plates which set up a small electromagnetic field. As the radio-frequency current passes through the material, heat is generated by dielectric loss. This heat causes thermoplastics to fuse in a tight bond. By generating heat inside the material itself, this machine is described as overcoming the problems of maintaining uniform temperature and of keeping the processing equipment from becoming gummy. In appearance the unit is much like a conventional sewing machine. The radio device derives its current from a low-power radio-electronic oscillator, while a small electric motor drives the roller wheels.

★ A MULTI-PURPOSE GRINDER, DESCRIBED AS offering greater flexibility and wider range of work than heretofore possible on any one model, is available from Sav-way Industries, Machine Tool Div., Detroit, Mich. Holes from $^1/_4$ in. to 18 in. in diameter and up to 9 in. deep, straight or tapered sides, may be ground on this machine. Construction of the headstock permits an adjustment to a distance of $3^1/_8$ in. at right angles to the wheel transverse by loosening two nuts. The grinding wheel head may be adjusted to .0001 and the diamond holder is of the swing type with micrometer adjustment permitting the diamond to be set accurately for sizing holes. The machine has an eccentric bushing between rack and gear.

★ BLAKE AND JOHNSON CO., WATERVILLE, CONN., have introduced a new screw for wood, plastic and combination assemblies under the name Twin-Fast Screw. This screw has two parallel threads which start at opposite sides of the shank and terminate in a single, centered point. The self-tapping and cylindrical contour are described as increasing strength and holding power, allowing the use of fewer and shorter screws. The single, sharp point of this screw is said to eliminate eccentric movement and thus prevent misalignment of assemblies while the relieved shank diameter lessens danger of fractures or ruptures in assemblies subject to changes of temperature and humidity.

★ ROBERT H. CLARK CO., LOS ANGELES, CALIF., announces an adjustable tool for surface facing in horizontal or vertical milling machines, lathes and other spindle machines. It consists of tapered or straight shank and body with 3 adjustable high speed bits which it is said can be easily reground or replaced. Complete set of 4 Clark Surface Facers covers fractional and decimal expansions of 1 in. to 5 in.; each model is claimed to cover the range of several standard facing tools. A measuring gage is provided with each tool.

★ VERSATILE AND SIMPLE TO USE, SUPERIOR INstruments Co., New York City, makes a voltage tester which operates by simply connecting the needle pointed test prods across any electric line. Voltage, frequency, type of current and other data are automatically recorded in the manner of a thermometer. The instrument is said to be ruggedly constructed to withstand the hard knocks of maintenance work. Size: $1^3/_4 \times 5 \times 1^5/_7$ in.; weight, 5 ounces.

★ A NEW LAMINATING hydraulic press described as having many advantages over old, hand-operated units has been developed by Williams Apparatus Co., Watertown, N. Y., for the U. S. Government. Rapidity of operation is obtained by a special pressure development method. A spin of the vertical hand wheel secures long-travel and medium pressures while a few turns of the horizontal wheel forces a 1-in. plunger into the oil well to obtain high pressures up to 30 tons and more. The temperature of the electric hot plates, $9^5/_8$ in. $\times$ $9^5/_8$ in., 92 sq. in., is closely controlled by thermostats. Since they are cooled with compressed air, the heat may be dissipated rapidly. These plates are machined and faced either with polished stainless steel or Monel metal.

The press is understood to be well adapted to plastic research work, laminations and impregnations of cloth, wood.

★ HIGH SPEED RECIPROCATING ACTION WITH A unique principle that eliminates violent vibration is combined in the Nedco Model R, a sanding unit designed by The Lintern Corp., Berea, Ohio. Balanced weight and smooth action are said to facilitate even pressure, with only guidance necessary by the worker. The natural hand grip close to the work assures good control. The unit plugs into nearest outlet and is ruggedly constructed for continuous production work. Motor may be removed without disturbing drive assembly.

★ TO ASSIST INTRA-DEPARTMENT HAULING OF large unit loads, temporary storage and precise positioning of multi-unit assortments of materials, Towmotor Corp., Cleveland, Ohio, offers a simple and effective rolling rack system to be used with standard fork lift trucks. The racks, caster equipped and adjusted on standards to accommodate many different types of load, are picked up by the trucks and taken to their destination. They are then easily removed and can if necessary be rolled short distances for exact positioning.

Engineering properties

(*Continued from page 97*) with a thermoplastic material. The amount of creep is considerably higher than that for the thermosetting plastic at much less stress and is more affected by small changes in stress.

The time-fracture data in Fig. 5 indicate that the decrease in stress with time is greater for the thermoplastic. At 1000 hr., the thermosetting material did not fail at a stress less than 50 percent of the static tensile strength. The corresponding value for the thermoplastic is about 45 percent of its static tensile strength. Creep of aircraft metals at room temperature is practically nil.

Impact data. The data presented in Table IV were obtained on standard 45° V-notched Izod specimens in a plastics Izod impact tester. The values for plastics in general are very low, being considerably below that for aluminum alloy except those for the glass fabric material and the low-pressure, cotton-filled plastic. The impact resistance of material with the notch on the face is higher than that with the notch across the edges of the laminations.

Acknowledgment

The author wishes to acknowledge appreciation to J. B. Johnson, Chief of the Materials Laboratory, and to the following personnel in the Structural and Mechanical Test Branch of the Materials Laboratory who aided in the compilation of the data and in the testing of plastics: R. T. Schwartz, D. A. Shinn, B. Chasman and D. Bremmerman.

TABLE IV.—AVERAGE LONGITUDINAL IZOD IMPACT RESISTANCE OF PLASTIC MATERIALS

Material	Izod impact resistance Notch on edge	Notch on face
77° F.		
	ft.-lb./in. of notch	
Grade XX phenolic	0.6	2.3
Grade C phenolic	1.9	2.7
Grade L phenolic	2.2	4.4
High-strength paper, phenolic	0.7	3.2
Glass and cotton, phenolic[a]	18	22.5
Glass fabric, urea-phenolic[b,c]	26.3	..
Cotton, urea[d]	12.2	..
Seat; cotton, urea[e]	2.1–2.9	..
Al. alloy 24S-T	25	20
−67° F.		
Grade XX phenolic	1	1.9
Grade L phenolic	2	3.1
Glass and cotton, phenolic	27.5	30.5
+158° F.		
Grade XX phenolic	0.5	2.5
Grade L phenolic	2	5.3
Glass and cotton, phenolic	15	20.5

[a] Fiberglas fabric No. OC-63; glass warp, muslin fill.
[b] Copolymer urea-phenol-formaldehyde resin.
[c] Fiberglas fabric No. ECC-11-161; thread count, warp 29/in., fill 17/in.
[d] 6 oz. canvas; thread count, warp 38/in., fill 24/in.; modified urea-formaldehyde resin.
[e] 8.5 oz. cotton fabric; 30 threads per in. warp and fill; modified urea-formaldehyde resin.

TABLE III.—AVERAGE FLEXURAL PROPERTIES OF PLASTIC MATERIALS

Material	Specific gravity	Direction	Proportional limit, tangential	Modulus of rupture	Modulus of elasticity
			p.s.i.	*p.s.i.*	*p.s.i.* $\times 10^{-6}$
Grade XX phenolic	1.34	Longitudinal	7,800	18,400	1.55
		Transverse	6,300	16,100	1.28
Grade C phenolic	1.34	Longitudinal	4,000	21,400	1.35
		Transverse	4,000	16,300	1.05
Grade L phenolic	1.34	Longitudinal	3,900	21,400	1.36
		Transverse	3,800	18,200	1.06
High-strength paper, phenolic	1.39	Longitudinal	10,700	28,400	2.26
		Transverse	9,300	29,700	2.15
Glass and cotton, phenolic[a]	1.64	Longitudinal	12,500	34,800	2.15
		Transverse	10,500	33,800	1.81
		45°	2,800	24,900	1.26
Glass fabric, urea-phenolic[b,c]	1.74	Longitudinal	6,900	18,400	1.54
Cotton, urea[d]	1.22	Longitudinal	1,700	6,400	0.43
		Transverse	1,300	9,600	0.42
Flap; cotton, phenolic[e]	1.28	Longitudinal	7,100	13,400	0.78
		Transverse	8,600	12,000	0.71
Seat; cotton, urea[f]	1.40	Longitudinal	....	12,100	...
		Transverse	....	12,700	...
Al. alloy 24S-T	2.77	....	35,000	62,000	10.5

[a] Fiberglas fabric No. OC-63; glass warp, muslin fill; thread count, warp 54/in., fill 12/in.
[b] Copolymer urea-phenol-formaldehyde resin.
[c] Fiberglas fabric No. ECC-11-161; glass warp and fill; thread count, warp 29/in., fill 17/in.
[d] 6 oz. canvas; thread count, warp 38/in., fill 24/in.; modified urea-formaldehyde resin.
[e] 10 oz. cotton duck; thread count, warp 59/in., fill 32/in.; phenol-formaldehyde resin.
[f] 8.5 oz. cotton fabric; 30 threads per inch warp and fill; modified urea-formaldehyde resin.

Design suggestions

(*Continued from page 93*) avoided. These designs are illustrated in the three line cuts which comprise Fig. 6.

Letters are designed with a raise of 6 to 10 mills, except on parts of high activity which warrant hobbed molds. Letters on rounded surfaces are avoided (Fig. 7).

Holes and threads introduce important tenets of design. Side holes are shunned because they require pins that lie across the direction of pressure and are likely to become bent or fractured. Holes molded partially through the piece should not be designed with their depth greater than their width. And holes molded all the way through should be of two widths, with the larger extending the greater part of the depth (Fig. 8). Molded threads are better with large pitch because fine threads are composed chiefly of resin, with little filler material to add strength.

Inserts and assembly are often interdependent, since inserts are used for two purposes: 1) to add strength, and 2) to facilitate assembly. The inserts are placed on locating pins in the mold. Then under heat and pressure the plastic flows around the insert. Because of the difference in thermal conductivity, the insert is held securely upon cooling. To insure against the insert twisting or pulling out under stress, it is designed with a diamond knurl or as undercut hexagonal stock (Fig. 9). Straight knurls, also used, are less expensive than diamond knurls, but they do not prevent the insert from pulling out.

There is an optimum size of the insert. If it is too large a proportion of the total piece, there may not be sufficient plastic to absorb the strain of shrinking without cracks. However, the insert must be large enough to transmit and distribute stresses of later operation over as large an area of the molded phenolic piece as possible to prevent creep and subsequent loosening of the insert. Screw machine inserts equipped with threads are preferably positioned on a shoulder to prevent the resin, which has great penetrating power, from filling up the threads.

The correct designing of assembling devices that fasten two molded pieces together or a molded piece to other materials is guided by considerations of strength, appearance and adaptability to mass production. Strength requires that the permanence of assembly does not depend on the creep resistance of the molded phenolic. The most desirable design applies and distributes stresses in the metal parts wherever possible. Otherwise, dished out washers and speed nuts are used to maintain the tension of assembly.

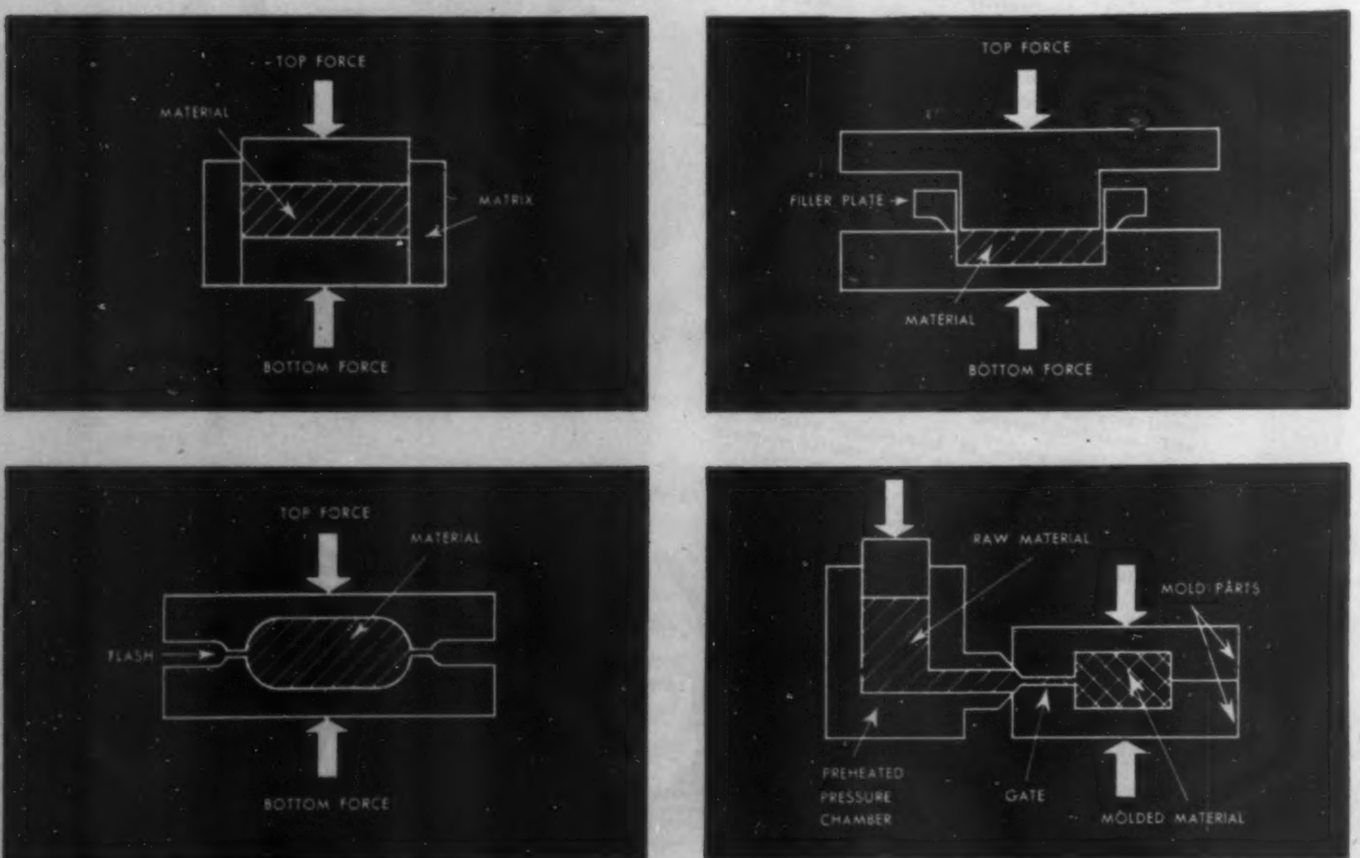
Where appearance is important, decorative Gulmite head and cross-slot head screws are used with molded inserts. Also, riveted assemblies, in which eyelets are pressed into a molded shell and riveted over, present a pleasing appearance. Adaptability to mass production demands that speed of assembly be ensured by the use of speed nuts, attached lock washers, riveting and other time-saving devices. Also, interchangeability of parts makes easier the job of adapting a molded phenolic to mass production.

Process of manufacture—forming

After the requirements of application are clearly defined and met by the combination of properties offered by a certain commercial grade, and the job has been successfully designed, the final step is the actual processing of the filler and resin of the chosen grade, and the manufacturing of the finished piece by the successive stages of forming, molding and finishing.

The form used depends on the type of filler and on the

13—*Flash, filler plate, positive and transfer types of molding*



influences of strength, intricacy of design and production turnover. The resin-treated filler, of chosen grade, is processed to the form used by die cutting, as in the laminate form, by chopping, as in macerated, or by sawing, as in the powdered and laminate forms.

Prior to molding, the processed material very often is weighed out and cold-molded to a biscuit of approximate ultimate shape by an operation known as preforming. Preforming is used when possible because it catalyzes production by decreasing time required to load a multi-cavitied mold and by curing the material in approximate ultimate shape faster with less flow. In addition, less material is wasted and there is less danger of contamination when preformed biscuits are used.

Molding

Two principal determinations at this stage are the types and conditions of molding. The types of molding all belong to the general class of compression molding and are similar, since these thermosetting materials cannot be held in the fluid condition long without conversion. The four molding types are shown in Fig. 13.

The choice of molding type depends on the characteristics of the finished piece as to depth, density and shape, the specified tolerance and the allowable mold cost. Flash molds, for which preformed biscuits are required, are good for relatively thin sections and for small and fairly simple pieces. The excess charge is expelled or flashed off between mold members. Compared to other types, the flash mold is inexpensive.

Positive molds are chosen for dense, deep draw pieces. This is because full pressure is on the pieces. The closely telescoped parts of this mold make it more costly to build and maintain than the other types. Filler plate molds which possess a loading chamber for material combine the advantages of the flash type without the need for preformed biscuits. In the transfer molds, pressure is not exerted on the whole area of the piece. Instead, the charge is forced through a small orifice into the cavity. The result is a gentle flow which permits the use of small and delicate inserts.

The conditions of molding rely on three agents of influence: time, temperature and pressure. The time of the molding cycle (heating and cooling) varies with the resin and filler form used and with the thickness of piece. Fast cure resins and powdered fillers cure most rapidly.

Sufficient heating time must be provided thoroughly to permeate the thickness of the piece and cure the resin, and sufficient cooling time for prevention of blister or air pockets. The average molding cycle for a piece $^1/_2$ in. thick is about 15 min., while a piece 3 in. thick may require $1^1/_2$ hr., a nearly direct variation on the basis of $^1/_2$ hr. per in. thickness.

Uniform temperature control is very important since fluctuations produce undercured or overcured pieces that may be weak and discolored. A mold temperature which varies between 135° C. and 180° C. is needed properly to polymerize the resin.

The pressure must also be steady. Density and the maintenance of proper tolerances are dependent on uniformity of pressure. Two thousand lb. and upward per sq. in. of projected area are applied.

Finishing

After any necessary machining operations (held to a minimum by the very nature of molded phenolics) there are three finishing operations: removal of flash by tumbling or

sawing, filing off rough edges and buffing the piece with wax to a polished finish.

After forming, molding and finishing have been completed, the resin-impregnated filler has been processed through the three successive stages of manufacture. Molded phenolics are used, therefore, by exploring the requirements of application, by choosing the suitable commercial grade, and then by designing and manufacturing to completed form.

Molded phenolics have proved versatile in a variety of past applications. And the future, too, will be a continuation of the past, in which each tomorrow will usher in exciting new possibilities—possibilities that will both fire the enthusiasm and challenge the imagination.

Improved methacrylate

(Continued from page 100) HM-113 and HM-102 were plotted in comparison with dimensional changes of the heat-resistant HM-119.

In Section A, Fig. 7, one notes that a condition of equilibrium, relative to dimensional change, was reached with HM-119 after about 5 minutes' immersion. The dimensional change was about 1.5 percent, and from there on it remained constant regardless of immersion time. General-purpose types, HM-102 and HM-113, showed approximately 10 percent dimensional change after 1 hr. of immersion.

Decreasing the thickness of the test bars also affected heat-resistance. Formula HM-119, however, still shows its superiority in Section C of the graph, based on $^1/_{20}$-in.-thick specimens.

Another interesting fact was brought out in this work, and that is that the heat-resistance of a methyl methacrylate molded article is affected by the cylinder temperature used when injection molding the article. In the case of the general-purpose methyl methacrylates, the use of high cylinder temperature is conducive to reducing the dimensional changes of the articles when exposed to elevated temperatures. This is shown quite clearly in section B of the graph where, in the case of HM-102, injection molded with the cylinder temperature at 410° F., a 15 percent change resulted on a 60-min. immersion in boiling water as compared to a 9 percent change in an article molded at a higher cylinder temperature, namely, 450° F. The same phenomenon occurs with general-purpose methacrylate formulation HM-113, where again the higher cylinder temperature yielded an article less subject to distortion by heat.

In contrast, however, to the use of high cylinder temperatures for general-purpose methyl methacrylate to develop the best heat-resistance, we have found that it is desirable to use, in the case of HM-119, the lowest cylinder temperature necessary to fill the die. As shown in this graph, HM-119 injection molded at 510° F. cylinder temperature, developed a 7.5 percent dimensional change on boiling, while the article molded at a 470° F. cylinder temperature changed approximately 2.5 percent at the end of 1-hr. immersion in boiling water.

In order to determine the effect of dry oven heat, 212° F., on the heat-resistant methacrylate molding composition, in comparison with the dry heat-resistance properties of general-purpose methacrylates, a series of experiments similar to the preceding boiling water immersion tests were run. These tests were made with $^1/_4$-, $^1/_8$- and $^1/_{20}$-in.-thick injection-molded test bars and strips. One set of general-

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purpose HM-102, HM-113 and heat-resistant HM-119 bars was placed in an oven at 212° F. for 10 min., removed, cooled to room temperature and the decrease in length determined. A second fresh group of bars was placed in the oven for 20 min., cooled and measured, and so on for 10-min. intervals up to and including 60 minutes. The data plotted in Fig. 8 again show the superior heat-resistance of HM-119 under conditions of dry heat as well as immersion in boiling water.

In order to show the comparative flow properties of the heat-resistant formulation as compared to the general-purpose formulation, the flow curves have been charted in Fig. 9. It will be noted that, in line with this increased heat-resistance, HM-119 possesses the highest flow figure, namely, 170° C. HM-113 is next down the scale with a flow of 160° C., followed by HM-102 with a flow of approximately 130° C., and HM-118 of 125° C. The fact that HM-119 requires more heat in order to provide a good flow makes it just a bit more difficult to mold. Its molding range is less broad than the molding range of the general-purpose types of materials.

Summary

A new heat-resistant methyl methacrylate molding composition has been developed which will yield molded articles possessing 30° to 50° F. higher service temperatures than the same articles molded from general-purpose types of acrylics.

The new molding composition can be molded on the same machines and with the same cycles used for the general-purpose types of methacrylate molding powders.

If current general-purpose molding types of methyl methacrylates are providing satifactory end-use properties, the use of the heat-resistant grade is not commended because it is a bit more difficult to mold in that its molding range is somewhat narrow and critical. The heat-resistant grade should be used only where heat-resistance in the molded article is essential.

Allyl-type cast resins

(*Continued from page 104*) of long cure time, limited formability and inhibition of cure by air are on the road to solution in the laboratory.

Since the material is thermosetting, the fully cured resin is insoluble in organic solvents. Accordingly, it cannot be used where applications of resins in solution are demanded. This is particularly true in items such as the coating of fabrics, painting of surfaces and the like. Since the materials are of low viscosity, complete rather than imperfect impregnation is usually achieved and, accordingly, very low density or "foamy" products are difficult to make. In the cure of the material the polymerization involves some shrinkage and mold design must take this into account. Since the materials are thermosetting in their final condition and show no plastic flow, those applications which involve fusion of resin cannot be satisfied at the present time.

There is one factor which is today of even greater importance than any of those mentioned above. Due to the lack of large production facilities for allyl alcohol, the monomeric materials are not available in production quantities and only those applications directly related to this country's war effort can be considered at the present time.

Army foot tubs

(*Continued from page 83*) emery paper or its equivalent. The tension testing machine shall be operated under load at a jaw speed of 0.15 to 0.25 in. per minute. The distance between the jaws at the start of the test shall be approximately 5 inches.

Impact test—The finished tub, cooled to 32° F. by immersion in ice water or refrigerator for 2 hr., shall be able to withstand three consecutive drops to a smooth concrete surface, from heights of from 5 to 8 ft. without failure. Tub shall be dropped in refrigerated room or immediately after removal from ice water (temperature 32° F.) so that temperature of tub at time of impact shall be 32° F. maximum. Tub shall be dropped so as to strike concrete surface once on a lower edge, once on a rim edge, and once flat on bottom.

Water absorption—Two (2) pieces, approximately 1 in. × 3 in. × thickness of material, cut from bottom or side of finished tub, shall be subjected to a 24-hr. water absorption test according to A.S.T.M. D570–40T. The percent of moisture absorbed will constitute the "water absorption" of the material and shall not exceed 1.75 percent.

Resistance to chemicals: percent absorption and appearance—Eight pieces approximately 1 in. × 3 in. × thickness of material cut from bottom or side of finished tub shall be tested for resistance to chemicals as follows:

The pieces shall be weighed and then immersed, two each, in each of the solutions listed above for 24 hr. at a temperature of 120° F. At the end of 24 hr., the samples shall be wiped dry with a soft cloth and weighed immediately. The samples, after being tested, shall show no loss in weight. The total gain in weight for each sample (percent absorption) shall not exceed 2.0 percent. An examination of the samples thus immersed shall show no dulling, whitening, checking, swelling or other difference in appearance from the original.

Resistance to deformation—A finished tub shall be placed bottom downward on a level, flat surface and allowed to attain a temperature of 70° to 80° F. The tub shall be filled with hot water at a temperature of 200° F. and then allowed to cool slowly without any support other than the level, flat surface. The water when cooled to from 70° to 80° F. shall be emptied from the tub. The tub shall then be measured and inspected for deformation. The walls and bottom of the tub shall not show a bending or bulging out of shape to the extent that the tub would be considered unusable for the purpose intended.

While a bit of difficulty was experienced in passing important strength tests at the start of this job, it was found after considerable experimentation that a soft material (S7) would easily pass the drop test.

Molds

The design and construction of the molds used to produce the foot tub pictured in Fig. 2 required considerable study as these units were, to our knowledge, one of the largest thermoplastic parts ever produced. It was decided to build a semi-positive mold to operate semi-automatically (Fig. 3). Aside from the difficulties of handling a mold of this size, the construction of it was relatively simple because of the plain design of the tub. The cutting and finishing work on the ribs was the slowest tool work, as most of the roughing out of the cavities and forces was completed on a duplicator.

The most important engineering detail connected with the design of these molds was the method of channeling them. As the tubs were to be produced by the compression method

of molding, it was necessary to construct the molds so that they could be heated and then quickly cooled. After designing several methods of channeling the die, it was finally determined that the manifold type was the most practical; and the minimum cycle possible for producing the tubs has been achieved with molds channeled in this manner. A steel plate was subsequently welded to the top of the force to eliminate leaks. The punch and cavity are attached to the top and bottom platens of hydraulic presses and the mold is heated and cooled by the alternate circulation of steam and cold water through the channels, which are cored directly into the mold. In order to cool the mold quickly, it was channeled so that the cooling agent (in this case cold water) could be circulated uniformly around the punch and cavity.

The molds were constructed from a high-grade carborizing steel and were hardened to 54 Rockwell. The mold was thoroughly polished to produce tubs with a high luster mold finish. A mold shrinkage of about 0.006 in. per in. was allowed in the tool.

Molding

The foot tubs are produced from single cavity molds on individual 500-ton semi-automatic hydraulic presses. In order to facilitate the processing of the tubs, it was found that dehydrating and preheating the plastic material tended to shorten the cycle and to eliminate flow marks. It was also found that preheating of the material added to the surface finish of the tub. During experimental runs, considerable difficulty was experienced with flow marks. Too much heat on the mold would cause heat marks which had the appearance of surface air locks. Excessive heating caused blisters and bubbles, and insufficient heat did not allow adequate flow of the material to fill the cavity completely or resulted in an incompletely welded piece.

In order to obtain a good finish on compression molded thermoplastic pieces with large flat areas molded from granular material, it is essential that the mold be relatively confined so that there is plenty of pressure directly on the material. Consequently the flash escape clearance was kept to a minimum. If the mold was too hot, the material quickly plasticized and filled the die before the operator could inject a sufficient amount of cold water into the mold, causing the material to sag and thereby producing objectionable flow marks, especially on the side walls and around the ribs. After reversing the flow of water during the chilling cycle to allow a faster ejection of steam and injection of cold water, this difficulty was overcome.

The cavity charge is about 10 percent over the weight of the finished pieces to allow for flash. Although the bulk of granulation of the butyrate material was approximately $2^1/_2$ to 1, this presented no problem in loading the mold, as the depth of the cavity was about 6 in. and the entire charge was only about 1 in. deep over the bottom of the mold.

A three-way valve was used to control the heating and chilling periods. Heat is applied for about 4 min. and the cooling period requires about $4^1/_2$ minutes. Loading and ejection of the part take another $1^1/_2$ min., making a complete cycle of about 10 min. per tub. While this may seem like a long period, it isn't too bad when it is realized that a complete unit is turned out in that time, whereas it formerly required about an hour to produce a rubber foot tub. The weight of the rubber tubs was about five times greater than that of the plastic ones.

About 350 tons pressure is used to produce these tubs, or a mold pressure of approximately 4000 p.s.i. As these units were produced on semi-automatic presses, there was

plenty of time for the material to heat thoroughly during the low-pressure travel of the platen. When the final high pressure was applied, the material was completely plasticized. The most effective molding temperature was found to be 276° F., using steam pressure of 150 pounds. The die was chilled to an ejection temperature of about 125° F.

Because of the difficult terrain in which our soldiers are operating and fighting today, it is especially important that all equipment necessary for their well-being and health be provided. In this, as in so many similar instances, plastics have again contributed their bit by supplying a required piece of Army equipment which could not at this time be produced from other materials.

Credits—Material: Tenite II. Molder: Eclipse Plastic Industries.

The future of design

(*Continued from page 77*) hallmark of "modern design"—as the mysterious and attractive solution for almost any application requiring "eye appeal." Many a time a product redesign was analyzed not on the basis of "What can I do to improve its operation, maintenance, manufacture and appearance?" but rather on "What do I have to do to make it of plastics?" It was a carefree, luxuriant period, full of innocent pranks and colorful publicity. It is gone forever, this past of our lost peace and, while we may look back upon it with understandable nostalgia, there is no need to lament its passing.

Then came Pearl Harbor and the trying, confusing period of conversion to total war. The consumer goods and transportation industries, which had given plastics and the designer much of their fame, were suddenly lost as customers. The question quickly became one of being able to produce merchandise—any merchandise, no matter how it looked. The race for substitute materials was on and again the plastics filled many a breach left by the no longer obtainable metals. Finally, the party was over, and nonessential and civilian goods and materials fell under the regulations of WPB and the War Manpower Commission. This was war and it was eminently proper that nothing but the needs of victory should determine survival.

Here also was the test of industrial design. Would it be able to assert itself through its ability to contribute to the war effort, or would it be rationed out of existence together with the second cup of coffee and the spare tire? Now that the opportunity for wastefulness was gone, would the designer be able to keep pace with industry and show his real mettle? I believe that now, in the second year of war, we can begin to appraise the results of war upon industrial design. I further believe that it has proved itself and has, in fact, contributed more to its permanent status than in any previous period.

It was obvious at the beginning of the war that the industrial designer was ideally suited to guide industry in its search for substitute materials. The range of the designer's knowledge of different materials, and his unspecialized yet analytical, approach to problems of manufacture, gave him an advantage over many a more conservative production expert. Far from being disturbed by the loss of flashy style features, the designer was at last able to use logic and knowledge instead of ambiguous intuition. Economy of production, material and assembly became a national need and the designer proved

what ingenuity and imagination could achieve under such apparent restrictions. As a matter of fact, during our two years of war industrial design has finally thrown off the superficialities of the past and has proved its worth in terms of essential services to the war effort. In civilian clothes as well as in uniform, design in terms of maximum performance through minimum means has, I hope once and for all, destroyed the notion that it is merely the extra icing on the cake of a product.

It is revealing to follow the careers of the young designers who have left college to join the Army. After an initial period of anxiety about what they could contribute to our armed services, many of them are now using what they have learned in the Administrative Command of the Amphibious Force, the Visual Aid Division of the Ordnance Department, the Camouflage Corps, and in other divisions where their knowledge of materials, production and mechanics contributes to the winning of the war.

This readjustment of design to the needs of war is tremendously encouraged by the requirements for more dependable standards for service established by our war agencies. The insistence in Washington upon absolutely calculable physical and mechanical properties of a given material is of inestimable help in taking both design and plastics out of the insecure stage of "promises" and substituting measurable figures of performance. You cannot gamble with our soldiers' and sailors' lives and it will be a fine thing if producers and designers will learn from this never again to promise more than they can perform. There is no doubt in my mind that because of such wartime tests and research the plastics industry will enter an era of peace in a considerably stronger position than it was when it left it.

But what of the future? How will design face the coming peace and what do the young designers expect from it? They are our future consumers as well as the designers of tomorrow—what are they thinking and talking of today, in school, in camps, overseas? Above all, they expect industry to provide them with the opportunity to realize their pent-up hopes and ideas. They have seen how far our industrial production can be made to go and they will not stand for less. Their acquaintance with military equipment, from jeeps to planes, has given young designers a new appreciation of the word "efficiency." The products and services of peace will be scrutinized with an expert's eye for value received. Dazzling finishes and fantastic shapes alone will not suffice to attract the buyer of the future. There is unlimited faith in the potential ability of industry to help build a new and lasting world of peace.

The young designers know of the gigantic increase in the production of old and new materials and have confidence in industry's postwar planning for their use. It is no secret that the plastics are expected to produce miracles of new applications and better products. The physical properties of the thermosetting resins, the transparent materials, and the ever-widening range and characteristics of the thermoplastics are eagerly looked to for radical improvements in our mode of living. Enormous interest in synthetic fabrics and plywood and in all aspects of postwar housing, transportation and communication is already producing many stimulating dreams that await only proper guidance to become realities. It is a dream of a richer and saner democracy born out of the bitter experiences of the war. *(Please turn to next page)*

The one very real danger for the postwar period may, however, lie in the scarcity of well-trained designers who then will be available. The draft now is taking its toll of even the sophomores and juniors, so that only few fully college-trained, let alone experienced, designers will be able to offer their services for the complicated problems of peace. Unlike the fields of engineering or medicine, the design field will have a definite shortage of men for industrial planning after the war. Considering the size and scope of the plastics industry, it seems strange that it has not as yet seen fit to endow a chair in Plastics at any of the recognized technical schools, where systematic research and training in fundamentals would create a backlog of experienced personnel. Metallurgy, medicine and engineering still have the jump on plastics through their tradition of professional training.

This would appear to be the next phase in the growth of the plastics industry and one which might merit consideration for the postwar era. Plastics design, as an integrated part of such a scheme, would help to avoid many costly mistakes of the era of reconstruction. One of the most expressive words which was coined recently and one which typifies the attitude of the designers today is the term "imagineering." Much of it is being done and plastics are receiving almost more than their share. It is up to industry to help win this war and thus the peace, and it is up to industry also to plan ahead boldly and imaginatively to meet the challenge of our youth.

Thermoelastic laminates

(Continued from page 70)

The object of plastics engineering at North American, according to Mr. Beach, is to "design and develop functional uses of plastics materials for practical applications in our airplanes whereby a definite decrease in weight or production costs or both is obtained over the use of metal." By making a little round pulley-like gadget with hole in the center, for example, plastics save 7 lb. per ship. There are 32 of these parts on each wing.

"Careful record is kept of each replacement," says Mr. Beach, "and we are making a worthwhile saving of weight and manufacturing time every month now by replacing a considerable amount of metals with plastics. We feel that only a small beginning has been made so far as possible uses are concerned. We haven't begun to investigate all the parts that need our attention."

Hydraulics in molding

(Continued from page 89) of the fiber tends therefore to catch up with the front end. Also, because in portion L the channel is expanding there is a sidewise (or expanding) velocity which tends to rotate the accordioned fiber to a position substantially perpendicular to the axis of the channel. As the fiber enters the larger straight portion D_2 it again begins to rotate to a position substantially parallel to the axis of the channel for the reasons previously discussed with regard to Fig. 2.

In Fig. 6 is illustrated a typical transfer gate where it enters the product. Usually, in order to prevent the gate from breaking into the product, a conical or tapered portion of gate is used adjacent to the product as has been illustrated

in Fig. 6. This tapered portion has the same effect on the fiber orientation as was previously discussed under Fig. 5. In Fig. 6 we have illustrated the fiber orientation which may be expected in such an application. It will be noticed that upon entering the tapered portion the fibers tend to accordion and re-orient themselves so that they are substantially horizontal as they enter the product. After entering the product, there are, however, two regimes of flow: one for the material moving directly downward from the gate, and the other for the material expanding sidewise

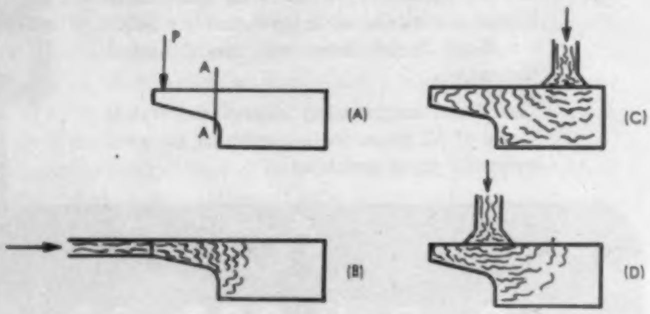

FIG. 7

from the gate. In this second regime of flow, the fibers tend to orient themselves so that they are lying substantially in spherical surfaces whose centers are at points A.

To illustrate the application of the above principles to an actual molding job let us now consider Fig. 7. In Fig. 7(A) are shown the outline of the product and the load P which will be imposed on it in service. Under such a loading, the part will tend to break in bending at section A-A.

In Fig. 7(B) we have illustrated the same product with the gate entering the lip from the left, and have shown the fiber orientation which might be expected under this type of gate. As can be seen, the fibers are lying in planes substantially parallel to section A-A and therefore they do not contribute their full value to the bending strength of the material at the critical section.

In Fig. 7(C) we have illustrated the application of the gate to the top face of the product adjacent to the right-hand side. In this case also the orientation of the fibers is such as to produce a weak section at A-A.

By moving the gate, however, to the position shown in Fig. 7(D), the fibers are oriented so that they lie substantially perpendicular to section A-A and thereby contribute their full value to the bending strength.

The foregoing discussion has assumed that all the fibers behave in a theoretically perfect manner but, of course, such perfection cannot be expected in practice. It has also been assumed that each fiber acts independently of all other fibers, and is not dissuaded from its particular theoretical course by its proximity to the remaining filler material. This perfection also is lacking in practice. Although it is acknowledged that actual molding materials will not behave in exact accordance with hydraulic theory, it is only natural to expect some improvement in physical properties if due account is taken of the theoretical background. In molding material filled with macerated fabric we cannot expect the pieces of fabric to operate as would theoretically independent fibers, but we can assume that they will tend to act in a theoretical manner and that by following the dictates of theory we can expect a higher quality product than we would obtain if theory were totally ignored.

Custom converter

(*Continued from page 54*) airplanes, to a giant of 12,800 lb. which is now used by the Maritime Commission for filtering the condensate from ship boilers (Fig. 9).

The latter case is an example of a plastic material's being used not as a substitute but in a completely new and valuable way. Previously there had been no adequate filter for ship boiler condensate, and chemical treatment of the water was not entirely satisfactory. Although the paper-pack filters are a recent development, indications are that they provide the complete answer to the problem. Manufactured by another Detroit company, the ship installations consist of a series of four tanks, or cylinders, each 6 ft. tall by about 4 ft. in diameter (see Fig. 9). Each installation requires nearly a quarter of a mile of the plastic paper for the "pack" which constitutes the filter element. Water goes through the four tanks in series, and is completely freed of oil and other undesirable adulterants which cause foaming in the boilers.

From the smallest to the largest, the principles of the plastic-paper filters is the same. The impregnation with phenolic resin makes the paper virtually indestructible and impervious to almost any liquid, including gasoline, oil, glycerine and ethylene glycol. Treatment of the paper is widely varied, however, according to the specific end-use. It may be either a smooth sheet or crêped in various degrees from 10 to 75 percent. The plastic treatment, in the case of the crêped papers, gives permanence of rigidity under any stress or condition encountered.

Generally, the cylindrical filter cores shown in the foreground of Fig. 10 consist of a pile of thin paper rings, clamped together under varying tensions and in some cases partially laminated. Even in the case of the small filters, this pack consists of thousands of layers of paper. The air or fluid to be purified passes through this "wall" of paper and is cleansed of all impurities. In all cases, the filter elements are readily cleaned when they have absorbed their limit and are again ready for use.

Typical uses of the simplest forms of filter packs are: in the automatic pilot mechanism, to filter oil; in vacuum-operated airplane instruments, to filter air; in de-icing mechanisms, to filter ethylene glycol; and in engine carburetors, to filter gasoline. Some of these filters are pictured in Fig. 9.

One concern, a division of a large automobile company, has made a straight substitution of paper for the tissue-thin plates of brass which formerly made up the core of its fuel filter. Production of these filters previously required 100,000 lb. of brass each month, 70 percent of it going to scrap. Substitution of the plastic paper eliminates the brass and gives superior performance. This filter operates on a slightly different principle in that the rings of paper themselves are perforated (Fig. 12), providing openings from end to end of the core "wall" itself. The liquid flows into the inside of the wall and is forced out through both sides. Various types of this fuel filter (at rear of Fig. 10), for both Diesel and gasoline engines, are generally used in tanks, trucks, jeeps and tank destroyers.

The resins used for impregnating the filter paper generally fall into two classes: water-soluble and alcohol-soluble. The big rolls of treated paper are simply slit into smaller rolls and shipped to the filter manufacturers for die-cutting.

Marine-tube bearings. Phenolic resin is used for treating 12-oz. Army duck which forms the huge plastic marine tube bearings used in ships.[1] Production of this important war

[1] MODERN PLASTICS 19, 33 (April 1942).

item has been expedited by the assurance of a steady supply of cloth, treated to exact specifications, some of which has been furnished by DWP. The plastic marine bearing has come into wide use in the last four years, having proved itself superior to lignum vitae, which previously was the classic material for this exacting use. The laminated phenol-formaldehyde material has high structural strength, low water absorption and is a good shock absorber. Chemically inert, it is not affected by pollution in river and harbor waters, and water acts as a perfect lubricant. It can be sawed, drilled, punched, turned or cut by machine tools, and in stern tube bearings has many times the life of lignum vitae.

The laminated plastic marine bearings are constructed up to 24 in. inside diameter, with a $1^1/_4$-in. wall, and 5 ft. in length. The impregnation job for these bearings represents an extreme in specifications, considering that the material must have a very low volatile and no flow. The treated material is shipped to the manufacturers either in rolls or sheets.

Airplane parts. A development of great possibilities in which the company is playing a part is the use of high-tensile plastic paper for the low-pressure molding of plane parts. This is a Forest Products Laboratory development which has been taken up by various manufacturing companies. The lamination is usually about $^1/_8$ in. thick. For this use the company supplies a high-tensile sulfite-base paper which is treated with phenolic resin. The resulting material is to be laminated at 325° F. Pressures as low as 100 p.s.i. can be employed, although the usual pressure is around 250 p.s.i. It can be molded with the usual type of laminating equipment, or by the rubber-bag method.

A sample of DWP's Grade No. 34 (see Fig. 11), parallel laminated and molded at 250 p.s.i. for 12 min., gave the following values when tested in the grain direction:

Ultimate tension	32,320 p.s.i.
Modulus of elasticity, tension	2,421,000 p.s.i
Maximum compression, edgewise, parallel to grain	19,940 p.s.i.
Modulus of elasticity, compression	2,133,000 p.s.i.
Modulus of rupture	30,000 p.s.i.
Modulus of elasticity, flexure	2,572,000 p.s.i.
Specific gravity	1.42
Water absorption (24 hr.)	4.1 per cent

The fabric chosen for impregnation for low-pressure molding (as distinguished from high-tensile paper) is usually 8-oz. bootleg duck (P-18), 40 in. wide. This is a grade with the property of two-way stretch for the molding of fabrications having compound curvatures. Average strength values of other molding samples of this grade, treated to a 54 percent resin content, were as follows:

Tensile strength	11,300 p.s.i.
Flexural strength	18,500 p.s.i.
Impact strength	1.4 ft-lb per sq. in.

Two experimental pieces, a connector box and a strut fairing illustrated in Fig. 11, were molded from this material on a hat press (see Fig. 6).

Credits—Helmet Liners: Mine Safety Appliances Co.; Inland Mfg. Co.; International Molded Plastics, Inc. Filters: Skinner Purifiers, Inc.; AC Spark Plug Div., General Motors Corp. Marine bearing: American Brakeblok Div., American Brake Shoe & Foundry Co. Airplane parts: Haskelite Mfg. Co.; Skaneateles Boats, Inc.; Ford Motor Co.

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(*Continued from page 126*) assuming the dependency situation is equal. For example, an employer with 100 draftable persons could list 25 for drafting and replacement within three months, 25 between three and six months and 50 after six months. When filled out and returned to the State Selective Service Board, it will, if approved, be assigned a "State Acceptance Number." The employer will then be authorized to use this number and to place a State Acceptance Stamp on the form 42A or 42B (depending on the dependency status) indicating that the time for release and replacement has been approved by the State Selective Service Director and constitutes a tacit agreement for deferment for the time indicated for each employee.

Before you fill out a replacement schedule go to your local Selective Service Board and ask for advice. Also ask for the address of the State Occupational Advisor and consult with him about your schedule before you submit it for final approval. Also consult with the Manpower Commission Office closest to you. The Manpower Commission may be able to recruit help for you from other areas, provide transportation for additional workers from near-by towns, advise on housing problems.

RESTRICTIONS OF ETHYL CELLULOSE

Use of ethyl cellulose except on specific authorization of WPB was restricted May 7, 1943, through issuance by WPB of ML Preference Order M-175 as amended, effective May 10. The amended order eliminates the general 50-lb. exemption for small orders and substitutes a general 10-lb. exemption and an exemption of 50 lb. in the case of acceptance or use for experimental purposes. Use of Standard Chemicals Allocation Form TB-600 and TB-601 by applicants for authorization to deliver, accept delivery of or use ethyl cellulose is provided.

BUTYL ALCOHOL AND BUTYL ACETATE

Ceiling prices for fermentation butyl alcohol were revised May 7, 1943, in Amendment No. 4 to MPR-37. The measure also revises ceilings for butyl acetate in line with the adjustments on butyl alcohol prices, since the price for the acetate is normally based on prices for butyl alcohol.

SECOND-HAND PLASTICS MACHINERY PRICES

Since WPB has taken over control of sale or transfer of all plastics machines with power to move them from one plant to another, it is wise for anyone with a machine in this category to carefully study OPA's Maximum Price Regulation 136, Amendment 76. This amendment was designed to encourage the sale of second-hand machinery so that equipment can be placed in essential production. It is of particular significance to plastics because of the great need for more facilities in this industry. In figuring sales prices for used equipment, the "seller" has a choice of two methods.

a. A "flat ceiling price" by which "as is" machines can be sold for 55 percent of the original sales price October 1, 1941, when machinery prices were frozen. "Guaranteed rebuilt" machines have a flat ceiling of 85 percent of the October 1, 1941, original sales price.

b. The "depreciation method" which is based on age of the machine and established depreciation rates prescribed by the Bureau of Internal Revenue. For plastics equipment as well as chemical process machinery, the rate is seven and one-half ($7^1/_2$) percent a year.

For an "as is" machine the seller may receive up to 80 percent of the original price by using the "depreciation method" if his machine is comparatively new.

If the age of a "rebuilt" machine does not exceed two years, the maximum price he may receive will range between 85 and 100 percent of the price of an equivalent new machine as of October 1, 1941. If the "rebuilt" machine is more than two years old, the seller may receive a higher price if he used the "flat ceiling"

formula which allows 85 percent of the price of an equivalent new machine, irrespective of age. A copy of Amendment 76 to MPR-136 or other information can be obtained by calling your nearest OPA office. MODERN PLASTICS' Bulletin No. 122 also gives detailed information on the two pricing methods and indicates which is best for machines of varying age.

ALLOCATION PROCEDURE ON ISOPROPYL ALCOHOL

Allocation procedure governing isopropyl alcohol has been simplified to reduce paper work by an amendment to General Preference Order M-168 on May 18. The amended order provides for use of Form PO-602 by a supplier (producer or distributor) seeking authorization to make delivery of or to use isopropyl alcohol. The supplier must submit to WPB end use information obtained from customers. The order previously required use of Forms PD-600 and PD-601.

INDUSTRIAL ALCOHOL STOCKPILE

The program of maintaining a large stockpile of industrial alcohol, announced by the Alcohol and Solvents Section of the Chemicals Division, WPB, was supported by the Alcohol Industry Advisory Committee at its April meeting in Washington. Present Government stocks are a little over 100 million gallons. Since the anticipated production of industrial alcohol for the next 20 months substantially equals the estimated demands for the same period, the desirability of carrying large stocks as insurance against unexpected demands was pointed out by Dr. Walter G. Whitman, Assistant Director of the Chemicals Division and Government Presiding Officer at the meeting.

PD-1A APPLICATIONS HANDLED BY FIELD OFFICES

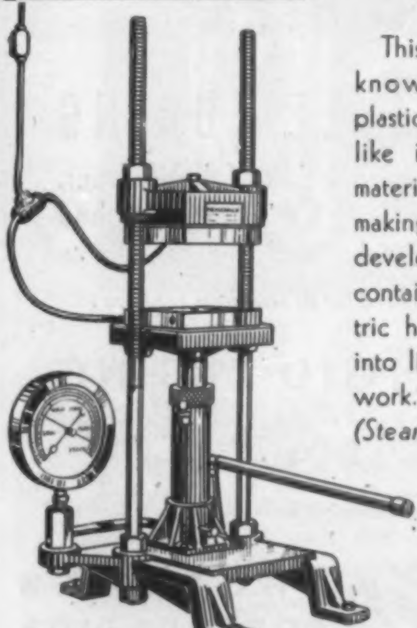
In line with its policy of decentralization, the WPB has ordered that all PD-1A applications involving not more than $500 worth of material on which priority assistance is requested are to be processed in either the District or Regional Offices according to the direction of the respective Regional Directors, except where specifically otherwise directed by the Director of the Distribution Bureau. In all other cases, PD-1A applications are to be forwarded by each field office to Washington, D. C., for routing in accordance with the regular procedure for processing such forms in Washington.

THERMOPLASTIC ORDER M-154 AND L-238

The use of thermoplastics in sun glasses, heretofore controlled under Thermoplastics Order M-154, has been placed under control by an amendment to Order L-238 dated May 25, which is administered by the Safety Division of WPB. Sun glasses will be eliminated from control under the Thermoplastics Order, but there is no change in restriction on their manufacture. Control has simply been taken out of one order and placed in another. Thermoplastics Order M-154 has also been amended to clarify the reference to combs. As now amended, it is made clear that the prohibition applies only to the manufacture of combination combs, those with attachments or plastic cases, and fancy side, back or tuck combs. At the same time, M-154 was clarified as to the use of thermoplastics in the production of "advertising specialties and other items used for advertising purposes, and miscellaneous novelties," which words were substituted for the previous wording, "advertising and miscellaneous novelties."

PHENOLIC RESIN GLUES FOR MARINE USE

At a conference of the Lumber and Lumber Products Division, WPB, which was attended by technicians of the Forest Products Laboratory and other Government agencies, it was decided that phenolic resin glues should be the approved bonding materials for the laminating of solid wood parts for marine use. A pilot plant under the supervision of the Forest Products Laboratory of Madison, Wisconsin, has been set up by WPB to determine technical manufacturing procedures and to recommend suitable specifications to avoid poor workmanship and unsatisfactory material entering this important program.



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ENGINEER WANTED

Mechanical or Chemical Engineer experienced in plastic compounding or moulding equipment. Must be capable of developing new equipment for a specialized moulding application. Permanent position. Midwest concern. Write stating experience, training, age and salary expected. Reply Box 778, Modern Plastics.

WANTED: Plastics Technician with general knowledge of entire plastic field and practices. Should have experience with resin formulating and manufacture; or plastic product development and molding of plastic products. Should have a degree in Chemistry or Chemical Engineering. Excellent opportunity for the right man for a position in a Research Laboratory. Reply Box 787, Modern Plastics.

WANTED TO PURCHASE: Injection molding machines in good condition. Please state size, price, make and other details. Reply Box 784, Modern Plastics.

POSITION WANTED: Married family man age 33, draft deferred, graduate of Plastics Institute, desires to make himself generally useful in plastic manufacturing industry. Reply Box 774, Modern Plastics.

EXPERIENCED MOLDING ENGINEER desires to make new connection. During the past few years, in complete charge of one of the leading Western Molding plants, with compression, injection, extrusion facilities. Extensive Engineering background. Draft status 4-H. West Coast preferred. Reply Box 777, Modern Plastics.

WANTED: Cellulose acetate. Any color. Any quantity. Medium soft flow. Will pay cash. Harry Broder, 5 East 47th St., New York City.

INDEPENDENT MANUFACTURER'S BROKER having 2000 jobbers, 16 offices covering United States, thoroughly acquainted in Midwestern Territory, interested in applying knowledge to prevent molding problems and post war developments. In position to make substantial investment in aggressive molding plant or will represent in sales and Merchandising capacity. Reply Box 785, Modern Plastics.

WANTED: Plastics laminator for work in experimental laboratory. Must be capable of impregnating various materials and laminating them in a hot press and in curved shapes in experimental bag molding autoclave. Knowledge of equipment and handling of resins is essential. Should have originality and prefer development work to routine production. War industry-release required. Reply Box 786, Modern Plastics.

ESTABLISHED FIRM interested in buying outright or interest in a Plastic Injection Molding Plant. Write full particulars as to size and equipment. Reply Box 783, Modern Plastics.

PAPER MILL experimenting in Laboratory with plastic laminates and molded pulp plastics wishes man with experience along these lines. Please give education, experience, age, and salary expected in first letter. Reply Box 780, Modern Plastics.

FOR SALE: 3—W.S. Hydraulic Presses, 12" x 12", 7½" Ram; 15" x 15", 8½" ram; 24" x 21", 8" Ram. 1—Robertson 13" x 16", 8" Ram. 1—400 Ton Hydraulic Extrusion Press. 1—80 Ton Hydr. Baler. 1—Ball & Jewell—#1½ Rotary Cutter. 1—W. & P. 150 gal. jacketed Mixer. Large stock of Hydraulic Presses, Pumps and Accumulators, Mixers, Grinders, Pulverizers, Gas Boilers, etc. Send us your inquiries. We also buy your surplus machinery. Stein Equipment Co., 426 Broome St., New York City.

WANTED: THERMOPLASTIC SCRAP or rejects in any form, including Acetate, Butyrate, Styrene, Acrylic and Vinyl Resin materials. Submit samples and details of quantities, grades and color for our quotations. Reply Box 508, Modern Plastics.

FOR SALE: Motor Driven Air Compressor, Size 12 x 10, 260 cu. ft. displacement, 100 lbs. pressure. Reply Box 512, Modern Plastics.

WANTED: Engineer thoroughly acquainted with the manufacturing methods, design of equipment and design of molds in plastics injection work. This is an excellent opportunity for advancement with a new injection development in a large corporation. War work and after the war. Only those eligible under WMPCES plan need apply. State training, experience, personal details and salary expected.

U. S. Rubber Co., Detroit, Mich.

MOLDS WANTED: We are interested in purchasing injection molds that will produce items in the hardware, toy or houseware lines Molds must be in good condition. Reply giving full particulars. Box 775, Modern Plastics.

WANTED: New or used Hydraulic Presses for plastic compression molding and injection machines for plastic molding. Reply Box 779, Modern Plastics.

WANTED: PRODUCTION MAN. Fabricator of Plywood and other woods resin bound. Write complete details of experience, age, salary expected, etc. Reply Box 782, Modern Plastics.

CHIEF ENGINEER wanted by a large Pennsylvania custom injection plastic molder. Must have successful record in injection plastic mold designing, molding technique, and related qualifications. Production and development projects included in duties. General engineering knowledge required. Highest salary for right man. Our men know of this advertisement. All replies will be treated confidentially. Reply Box 757, Modern Plastics.

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WANTED: Experienced molder of plastics for the development of molding equipment and the molding of asphaltic products. This work in development stage: company owns patent on molded asphaltic products. One of largest independent petroleum refiners in midwest. Reply Box 764, Modern Plastics.

ARE YOUR PRODUCTS REPRESENTED in the Baltimore, Maryland and Washington, D. C. markets? If your post war plans include the marketing of your products in this territory won't you communicate with me now. Reply Box 776, Modern Plastics.

WANTED: Small or medium sized plastic molding plant with either hydraulic extrusion or injection equipment with or without tool shop. Advise full details. Reply Box 788, Modern Plastics.

WANTED: Chemical engineer or chemist for field contact work and product control—essential war work. Must have experience in thermosetting powders, and if possible, experience on cotton fillers used in compounding. Give full details of age, draft status and experience. Location—R. I. Reply Box 781, Modern Plastics.

WANT TO PURCHASE: Five inch pocket comb injection mold. State number cavities, condition and price. Samuel Eppy, Inc., 333 Hudson St., New York City.

WANTED: PLASTIC SCRAP OR REJECTS in any form, Cellulose Acetate, Butyrate, Polystyrene, Acrylic, Vinyl Resin, etc. Also wanted surplus lots of phenolic and urea molding materials. Custom grinding and magnetizing. Reply Box 318, Modern Plastics.

WANTED: Hydraulic Presses, Preform Machine and Mixer. Stainless Steel or Nickel Kettles, Vacuum Pan. No dealers. Reply Box 275, Modern Plastics.

FOR SALE: 1—W.S. 15" x 18" Hydraulic Press, 10" dia. ram; 2—D. & B. 20½" x 20½" platens; 1—14" x 24" Press, 9" ram; 9—24" x 55" Steel Cored Heating Platens; 1—Farrel Birmingham 15" x 36" Rubber Mill; 4—W. P. Mixers; 1—Set of Compound Rolls 15" x 36"; Adamson 6" Tuber; Dry Mixers; Pulverizers, Grinders, etc. Send for complete list. Reply Box 446, Modern Plastics.

WANTED: PLASTIC PLANT. State full particulars Information held confidential. Reply Box 790, Modern Plastics.

WANTED: Hollow transparent plastic balls size 8, 10, 12 or 14" in diameter, either one piece or halves to be cemented together. Reply Box 789, Modern Plastics.

FOR SALE: 2—400 Ton Hydraulic Presses, 65" x 42" Platens. 1—175 Ton Hydraulic Press, 28" x 21" Platens. 1—150 Ton Hydraulic Press, 37" x 32" Platens. 1—Chambersburg Horizontal Hydraulic Pump, 3" x 12", 100 GPM, 2000#, Arr. for Geared M.D. 1—Worthington Duplex D. A. St. Dr. Hydraulic Pump, 14" x 2½" x 12", 50 GPM, 2000#. 2—Deane Triplex Vertical Hydraulic Pumps, 6" x 8", 200 GPM, 200#, Arr. for Geared M.D. 1—Weighted Accumulator, 13" x 12', Stroke Ram, 2000#, Tank 11' Diam. x 11' High. All Offered Reconditioned, Guaranteed, Prompt Shipment. Drawings and Other Data on Request. Other Sizes of Presses, Pumps, Accumulators, also Motors, Compressors, Boilers, Machine Tools, etc. Industrial Equipment Company, 876 Broad Street, Newark, New Jersey.

WANTED for Research Department which is being established by live New England Plastics Moulder, the three following Technicians:

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(2) Tool designer familiar with designing tools for compression transfer and injection moulded plastic parts, together with designing jigs and tools for further processing.

(3) Chemical engineer familiar with manufacture, usage, and testing of thermoplastic and thermosetting materials.

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